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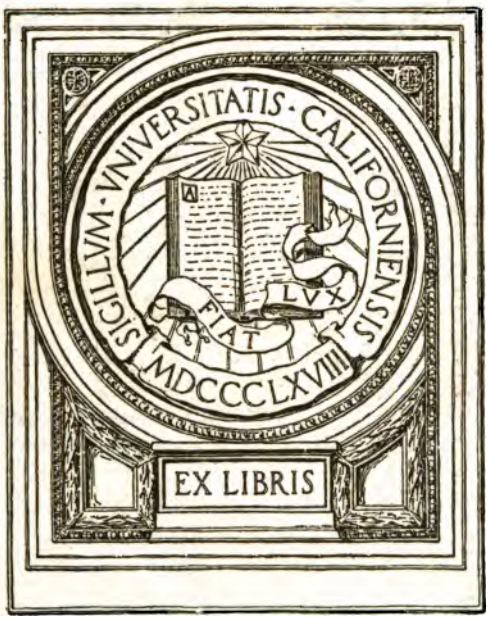

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PAINTING BY IMMERSION AND BY COMPRESSED AIR.

AUTOMATIC FINISHING OF PIANOS.
LOWERING THE LOADED CARRIER INTO THE VARNISH TANK.

Frontispiece.

Painting by Immersion and by Compressed Air.

A PRACTICAL HANDBOOK

BY

ARTHUR SEYMOUR JENNINGS, F.I B.D.,

Editor of "The Decorator" and the "The Decorator Series of Practical Handbooks," Author of "Commercial Paints and Painting," "Paint and Colour Mixing," "The Painters' Pocket Book," "House Painting and Decorating," etc., etc. Member of the Paint and Varnish Society, The International Society for Testing Materials, etc. Examiner in Painters' and Decorators' Work to the City and Guilds of London Institute.

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PREFACE.

In many industries the application of paint for preservative or ornamental purposes is imperative and the item of expenditure is an important one.

There is abundant evidence to prove that the application of paint, either by means of dipping. spraying or other mechanical means, effects an enormous saving of time over the old method of using brushes, while the coats of paint are more durable and thorough.

This saving of time not only lowers the cost of production to a very considerable extent, but it permits of a large increase in the output.

The process of "flowing-on" enamels and varnishes described in the following pages effects an even greater saving of time in those cases where it is applicable. The extent of this saving can be judged by the fact that a complete coat of enamel can be given to the body of a four-seated touring car in the almost incredibly short time of two minutes!

These processes are used to a very large extent in many industries, particularly those connected with metal work and engineering. In the United States of America and in many parts of the Continent they have reached a high degree of perfection. In Great Britain the adoption of the methods is rapidly increasing.

It is hoped that this book will be found of service to manufacturers who desire to ascertain whether the processes can be economically employed in their particular industry or to those who contemplate putting in a plant for the purpose.

It should also be helpful to those who have not been very successful with a trial plant or who desire to bring an existing plant fully up-to-date in its equipment. And it should be said at once that the few cases of failure which have come to the notice of the author have been found on investigation to be due either to the use of paint unsuitable for the purpose or the adoption of a plant which is unfitted for the object aimed at. Three examples may be given. In one small castings were dipped in black paint, but it was found that "tears," or runs of paint which did not dry properly, often occurred. Here, clearly, the

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paint was at fault. It was too thick for the purpose and did not dry hard quickly enough. The remedy was obvious.

In another case iron casements were dipped horizontally in a shallow paint tank and the time involved in lowering them to obtain a complete immersion was considerable. In this case the shape and size of the tank were not suitable. It should have been deep and narrow, so that the casements could be dipped vertically. The idea that the paint would "settle out" if a deep tank were used was shown to be erroneous.

In a third case spraying had been tried for coating metal casements, when it was found that the saving effected in time was more than counter-balanced by the waste of paint. Of course, spraying was not suitable for a job of this kind, the surface to be covered being so very narrow. Such work is done most successfully by dipping.

The degree of perfection to which the process of dipping has been carried in America is indicated by the fact that it is largely employed for piano cases and many other articles requiring a perfect varnish finish. This process is fully described in these pages and has been successfully carried on for some years. This fact demonstrates very clearly the possibilities of painting and varnishing by immersion.

All the principal appliances used for spraying paint, lacquer, enamel, varnish and similar liquids have been described at length, but no attempt has been made to prove that any one appliance is superior to another. The details of each apparatus are given, and for the convenience of the reader, the manufacturer's name and address. It is suggested that those who contemplate the adoption of paint dipping, or spraying, should get into touch with all these firms, and carefully investigate their respective merits before coming to a decision.

The services of an expert will usually be found desirable, for, although in engineering works much of the necessary apparatus and accessories may be made on the premises, the exact details, such as the kind of paint and the exact design suitable for the particular purpose, are largely matters to be decided upon in the light of experience.

ARTHUR S. JENNINGS.

365, Birkbeck Bank Chambers,
High Holborn, W.C.

August, 1915.

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CHAPTER I.

INTRODUCTION.

Until recent years, it appears to have been generally supposed that paint used for either the protection or ornamentation of various surfaces must necessarily be applied by means of painters' brushes made of hog's bristles. But it has been clearly demonstrated during the past few years that the application of the paint may be made by means of either total immersion of the article to be painted in a tank or by spraying the paint on to the surface with the aid of compressed air. The rapid increase in the use of both processes is principally due to the immense saving of time which is effected, and this may be approximately estimated at from five to nine-tenths. In other words, one man can do the work of from five to ten men, or even more. To put it another way, if a piece of work costs 20s. for labour in pa nting by the old process, it may be safely assumed that it can be done by dipping or spraying at a cost of from two to four shillings.

The question will at once suggest itself: "Is paint applied by dipping and spraying as durable as that applied by the brush?" As the paint in the greater part of work of this character is used solely for protective purposes, the question is clearly one of considerable importance. The answer to the question is that when properly prepared paint is used, both methods give an equal, or even better result from the point of view of durability than that which would be obtained if a painter's brush was employed, while, in the case of painting by immersion or by spraying, the paint finds its way into places which a brush could not reach, such as open joints of a waggon, the intricate parts of certain agricultural machinery, the inside of small metal boxes, etc.

Both methods are successfully employed in practically every branch of the engineering, metal and many other trades. Heavy steel sheets may be dipped provided that adequate plant is employed for lowering and raising them into the tank, or they may be sprayed without much difficulty. Children's toys (to take the other extreme),

costing less than a penny each, may also be economically painted by dipping. Speaking generally, anything large or small which can be handled or moved by lifting machinery or on a turn table, can be painted by either one process or the other. For example, a hundred or so of very small iron castings, or wrought iron ware, may be placed in a wire basket and dipped together in a few seconds, or the body of a motor car, or parts of a bicycle, can be painted by spraying in a fraction of the time it would take to do the work by means of brushes.

Thus far the processes are not much used in house painting, excepting for the first or priming coat, before the work is fixed in position, but certain types of the simpler form of spraying machines are employed with great advantage in applying lime white or whitewash to rough walls of factories, etc. In this case, a far better job is produced in one-tenth of the time. The whitewash, when sprayed on, enters and covers the open joints and inequalities of surface in a complete manner, which would be impossible were a brush used.

On the next page is a list of some of the principal purposes for which these methods are at present used, and these are being constantly added to. It is not too much to say that in any industry in which paints are used, one or other of the methods, or both in conjunction, may be employed with very great advantage in a saving of time.

An erroneous idea prevails in some quarters that to instal a paint dipping or a paint spraying plant will involve a considerable expenditure. As a matter of fact, if the work is of a simple character, and the articles to be dealt with small, an expenditure of something like £25 will be sufficient for the purpose. For example, a small tank, with a draining board attached, would cost less than the sum mentioned, even when the overhanging plant was included. As such work is usually done in engineering shops, the lifting apparatus and the rails, can easily be made on the premises. In some cases the lifting plant even might be dispensed with, and the articles, such as paint cans, could be dipped by hand. A spraying plant need not be expensive, and £25 to £40 will cover the expense of spraying apparatus, compressor for air spray, exhaust and everything else. This, however, refers to a small plant. More extensive installations would, of course, cost very much more, but whatever they may cost, it may be accepted as a fact that, within reasonable limits, the outlay will be fully returned in two or three years' working at most.

In the following pages an attempt has been made to cover the whole subject of painting by mechanical means. Many plants are described and illustrated, and some lengthy explanation is given of the requirements of different trades or goods. In many cases these have really nothing to do with the painting proper, but success depends upon the system adopted for handling and conveying.

Take, for example, celluloid buttons, which are usually sprayed. They are placed in wire trays made specially for the purpose, the bottom side uppermost. These are first sprayed all over with a spirit paint, and when sufficiently dry to handle, say, in a quarter of an hour, they are all turned over and the top sides are sprayed. The wire trays and a handy cabinet to contain them are the important details in this case.

LIST OF THE PRINCIPAL PRODUCTS TO WHICH PAINT SPRAYING AND PAINT DIPPING ARE APPLIED.

Acetylene Machines.
Adding Machines.
Addressing Machines.
Advertising Novelties.
Advertising Signs.
Aeroplane Work.
"Agate" Hollow Ware.
Agricultural Implements.
Air Compressors.
Aluminium Goods.
Antiques, Bric-a-brac.
Architectural Brass Works.
Architectural Iron Works.
Art Glasses and Mirrors.
Artificial Flowers.
Artificial Jewellery.
Artificial Marble.
Artificial Limbs.
Artistic Statuaries.
Automatic Vending Machines.
Automobile Lamps.
Automobile Licences and Number Plates.
Automobile Parts.
Automobile Parts and Motor Bodies.
Automobile Supplies
Automobile Tyres.
Automobile Tops and Canopies.
Axes.

Baby Carriages.
Badges.
Banners and Flags.
Bar Fixtures.
Barber Equipment.
Barrels.
Barrows.
Basket and Rattan Ware.
Bath Room Sundries.
Baths.
Bed Springs.
Bedsteads (Iron).
Bedsteads (Sheet Metal).
Beer Pumps.
Bells.
Bicycles.
Billiard Tables.
Bird Cages.
Blocks and Falls.
Blowers.
Boats.
Bobbins and Spools.

Boiler Work.
Book Cases.
Boxes, Cigar.
Bowling Alleys.
Boxes, Mail.
Brass Bedsteads.
Brass Goods.
Broom Heads and Handles.
Brushes.
Buckles and Snaps.
Builders' Hardware.
Burial Caskets.
Buttons (metal).

Cabinet Hardware.
Cabinets.
Cameras.
Candies and Confectionery.
Canners, Vegetables and Fruit.
Canoes.
Cans.
Cars.
Carpets.
Carpet Sweepers.
Carriages.
Carriage Hardware.
Casements (metal).
Cartridges.
Cash Registers.
Cash Carriers.
Celluloid Sheets.
Chairs (metal).
Children's Carriages.
China and Crockery.
Church and Lodge Goods.
Church and School Furniture.
Churns.
Clocks.
Colour Specimens.
Constructional Ironwork.
Corset Steels.
Coffins and Caskets.
Couches.
Cream Separators.
Curtain Poles.
Cutlery.
Cycles.
Cycle parts.

Desks (metal).
Display Fixtures.
Dolls.
Doors.
Drills.
Dynamos.

Edge Tools.
Electric Fixtures.
Electrical Apparatus.
Electrical Supplies.
Electro Platers.
Enamelled Metal Goods.
Enamelled Ware.
Engines.
Etching (metal).

Factory Fittings.
Fancy Baskets.
Fans.
Fenders.
Filing Cabinets.
Firearms.
Fire Extinguishers.
Fishing Rods.
Fixtures, Display.
Foundries.
Fountains, Soda.
Furniture (metal).

Garden Implements.
Gas Apparatus.
Gas Cookers.
Gas Engines.
Gas Fires.
Gas Fixtures.
Gas Meters.
Gas and Gasolene Stoves.
Golf Clubs.
Grates and Mantels.

Gramophones.
Grille Work.

Hats, Straw.
Hair Pins.
Hames.
Handles.
Harness Trim.
Harrows.
Hardware.
Hollow Ware.
Hooks and Eyes.
Horns.

Incandescent Lamps.

Japanned Goods.
Jewellery.

Kegs and Pails.
Kitchen Cabinets.
Kitchen Utensils.
Knitting Machines.

Lacing Studs.
Lamps and Lanterns.
Lasts.
Lawn Mowers.
Lead Pencils.
Leather Work.
Letter Files.
Locks.
Lockers (metal).
Looms.
Locomotives.

Machinery.
Malleable Castings.
Mathematical Instruments.
Meat Safes.
Metal Spinners.
Model Makers.
Motors.
Motor Cycles.

Musical Instruments.

Novelties.

Office Furniture.
Optical Instruments.
Ornamental Ironwork.

Pattern Makers.
Pen Holders.
Phonographs.
Physical Supplies.
Piano Plates.
Pianos and Organs.
Picture Frames.
Pins.
Plated Ware.
Ploughs.
Plumbers' Supplies.
Porcelain Goods.
Projectiles.
Pulleys (metal).
Pumps.

Radiators (auto).
Railway Carriages.
Rakes.
Refrigerators.
Regalia.
Rubber Goods.
Rules and Levels.

Saddlery Hardware.
Safes.
Safe Deposit Vaults.
Sashes (metal).
Scales.
Screens (metal).
Sewing Machines.
Shoe Buttons.
Show Cases.
Side Cars.
Signs, Enamelled.
Silverware.

Sleds and Sleighs.
Soda Fountains.
Sporting Goods.
Steel Stampings.
Stoves (gas).
Slate, Enamelled.
Statuary.
Steam Gauges.
Steel Castings.
Street Railway Companies.
Surgical Supplies.
Switchboards.

Tables.
Tanks.
Telephones.
Telephone Supplies.
Textile Machinery.
Tinwares.
Thermometers.
Tools.
Toys.
Trunk Hardware.
Typewriters.

Vacuum Cleaners.
Vending Machines.
Veneers.
Ventilators.

Wagons.
Wall Papers.
Washing Machines.
Watering Cans.
Weighing Machines.
Wheels.
Willow Ware.
Wire Cloth.
Wire Mattresses.
Wire Work.
Wringers.

In addition to the above, paint is applied by spraying for many artistic purposes, such as for show cards, photographic work, lithography, church decoration, etc. These are referred to in another chapter.

CHAPTER II.

Painting by Immersion.

The process of painting various articles by dipping them bodily into specially prepared paint contained in a tank or other receptacle is a very old idea. It has, however, developed considerably in late years, and is now largely employed in many industries, particularly in the finishing of agricultural implements of various kinds, iron work and a hundred and one other articles. It is sometimes used in conjunction with paint spraying; that is to say, the first coat or coats may be put on by immersing the article to be painted in the paint, or varnish, and the final coat of enamel or varnish may be put on by means of a spray. In some cases, the final coat is applied by means of brushes in the ordinary manner.

Perhaps the simplest form of paint dipping is that applied to various articles, such as bolts, rings and small parts, which are placed in a wire basket and plunged into the paint. The basket is then hung up for a quarter of an hour or so to drain, and afterwards in another place, until such time as the paint becomes hard.

Another familiar example of painting by dipping is that of ordinary tapered cans, such as those which are used to contain varnish, etc. In this case, a piece of wood is introduced into the neck, the can is immersed in the paint up to almost the top of the neck, and is then placed upside down to drain and to dry. A paint which dries with a gloss is usually employed for this purpose, and it may be remarked that a good deal of this work is now done by spraying; in fact, a great deal of difference of opinion exists as to the respective merits of the two processes for this particular purpose.

Going a step farther, we come to the consideration of articles such as iron sashes and casements, parts of staircases, etc., which may be dipped into a tank containing, say, five to ten gallons or so. Such tanks are usually made to

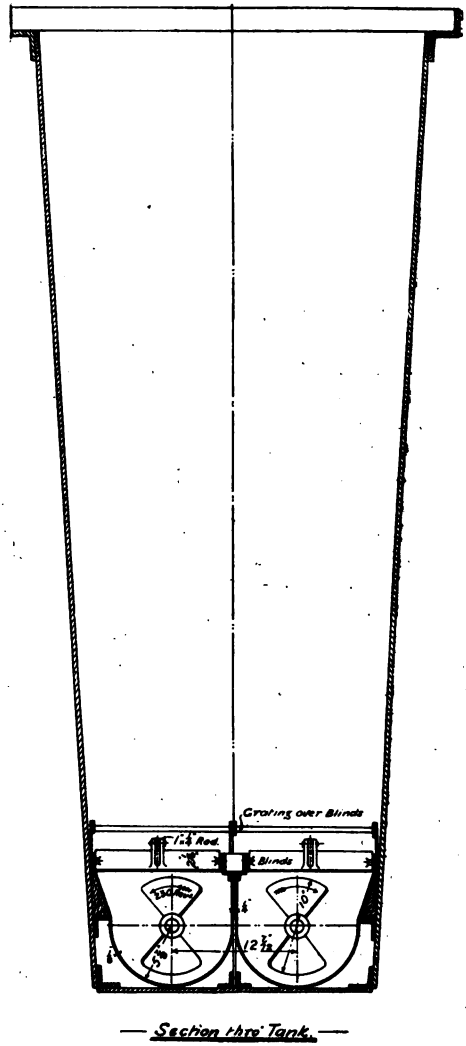


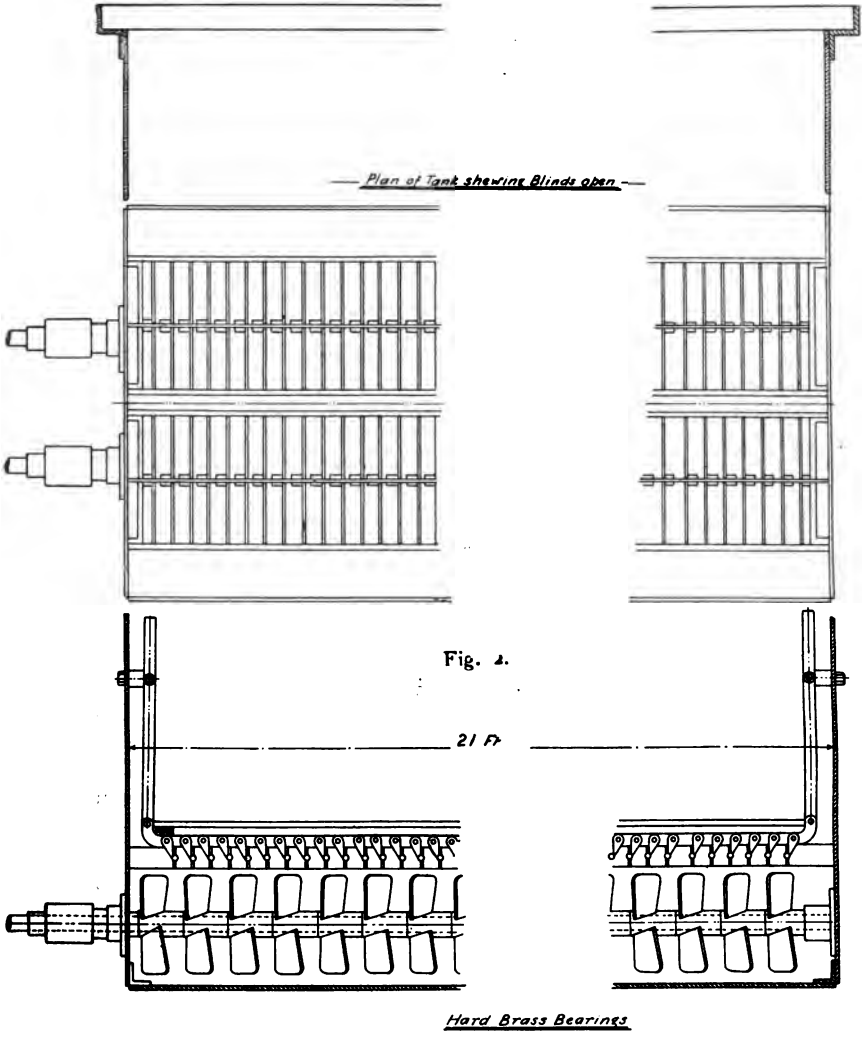
Fig 1.—Cross Section Through Paint Tank.

slant at the bottom in order to facilitate cleaning when necessary. Adjacent to them is provided a platform, usually lined with sheet iron upon which the paint can drip after the articles are removed from the tank, and a system of overhead rails for moving the articles from one part of the works to another. No agitating apparatus for the paint is required, but after the tank has been used for some time, say, for example, at the week-end, it is necessary to stir it up by means of a pole before the work commences. As a matter of fact, the articles being plunged in the tank, and their withdrawal, in itself stirs the paint sufficiently for the purpose.

In dealing with the larger-sized articles which are to be painted, such as reaping machines, the construction of the tank which may hold several tons of paint is naturally of a more elaborate character. Such a plant will consist, first, of the tank itself; next, the system of overhead railing; third, the apparatus upon which the articles to be painted are hung; and fourth, the hoists for lowering and raising such articles into and from the tank. It will be convenient to consider these parts which go to form a complete installation under their several heads, taking a more elaborate plant by way of example, it being understood that the plant may be simpler in form when the size of the articles to be painted is small, or under other circumstances, such as will be presently suggested.

THE TANK.

There are two forms of special tanks in general use, one having at the bottom paddles for agitating purposes, and the other worms provided with the same object. Fig. 1. shows a cross section of a tank made on the McLennan patented system. In this two series of paddles revolving in opposite directions are provided, and above them is an appliance which may be likened to a horizontal venetian blind, consisting of iron laths, which are nearly horizontal when closed, forming a platform upon which the paint can settle, and vertical when open. This blind is left open when the tank is in use, and is closed when it is at rest. The illustration gives the dimensions of the parts, although these, of course, will be varied according to circumstances. Above the blind is sometimes a grating, which, together with the blind, form a protection to the agitating gear from articles dropped into the tank by mistake, the two together preventing the heavy pigment in the paint from clogging the paddles when the



STIRRERS AND BLINDS FOR PAINT DIPPING TANK. Fig 2.—PLAN.
Fig. 3.—LONGITUDINAL VERTICAL SECTION.

agitating gear has been stopped for some time. Figs. 2 and 3 show respectively longitudinal plan and section, from which the construction will be clear.

Messrs. Wilkinson, Heywood & Clark, Ltd., of Poplar, who own the McLennan patents, in a little book, entitled "Painting by Immersion," state that there were certain disadvantages in the design of this tank, inasmuch as should it become necessary to remove or repair the paddles, it would be necessary to empty the tank and bodily remove the parts. They have, therefore, a new design, which is shown in Fig. 4, in which this remedy is overcome. The agitating gear, in this case, is on a sub-frame, separate and independent from the tank itself. The drive is in the tank, and is taken by means of a claw clutch through a right angled bevel to the agitating shaft. This design has proved very satisfactory for small tanks. For very large tanks a gear is recommended in which the agitating gear is enlarged and the shafting is supported or stiffened to prevent whipping. This entails a design of some special bearing, which should be paint proof and oil proof, for the reason that the bearing is immersed in the paint itself. In Fig. 5 is shown drawings of this bearing, on which the firm named hold patents. The perfected plants now consist of a tank with an independent and removable chassis frame, on which are mounted the venetian blind arrangements, already mentioned, together with the agitating gear, which consists of either one, two, or more parallel shafts, mounted on parallel gear, as shown in Fig. 6.

These shafts are held on the sub-frame with the patent bearings already referred to, and the drive is transmitted through the bevel gear encased in a special gear box, which is equally oil and paint proof and self-lubricating. It will readily be seen that with this plant it is an easy matter to withdraw the driving gear and lift the sub-frame bodily out, without in any way disturbing the paint in the tank. The tank, therefore, can be buried nearly flush in the ground, embedded in concrete, and need never be disturbed. In case of emergency, and when painting is continuous throughout the year, it is recommended that the consumer should keep a complete spare chassis for use when occasion requires.

Whatever the construction of the tank itself may be, and whether or not it is provided with agitating apparatus, it is generally found most convenient to build it with the top nearly level with the floor. It is advisable to provide iron doors or covers to close the tank in when out of use so

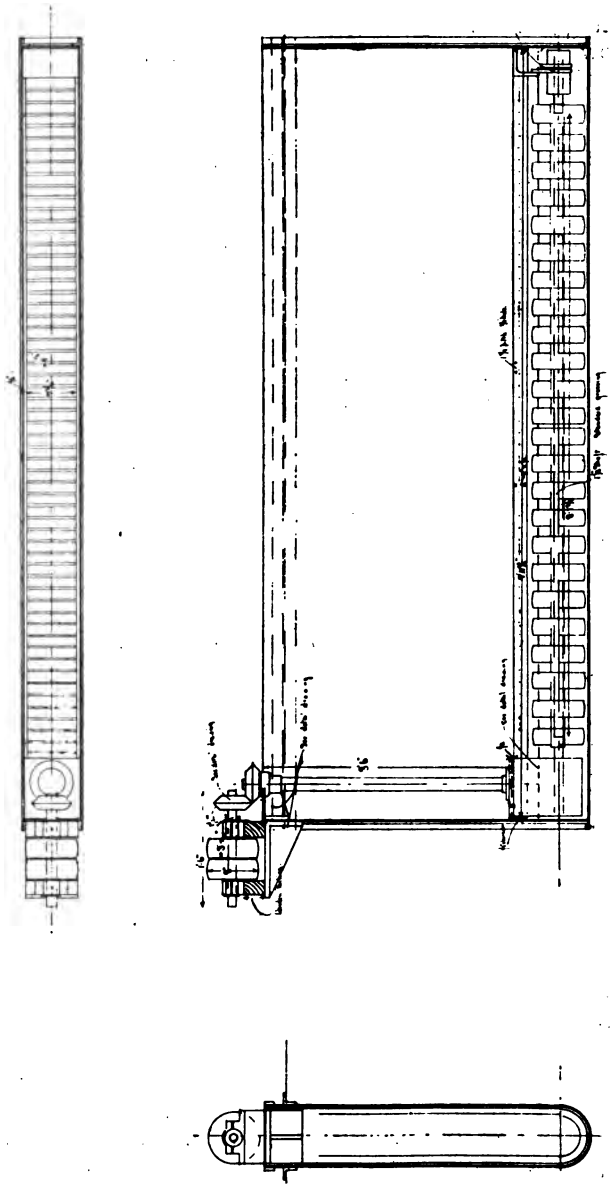


Fig. 4.—Design for Tank for Painting Steel Sheets.

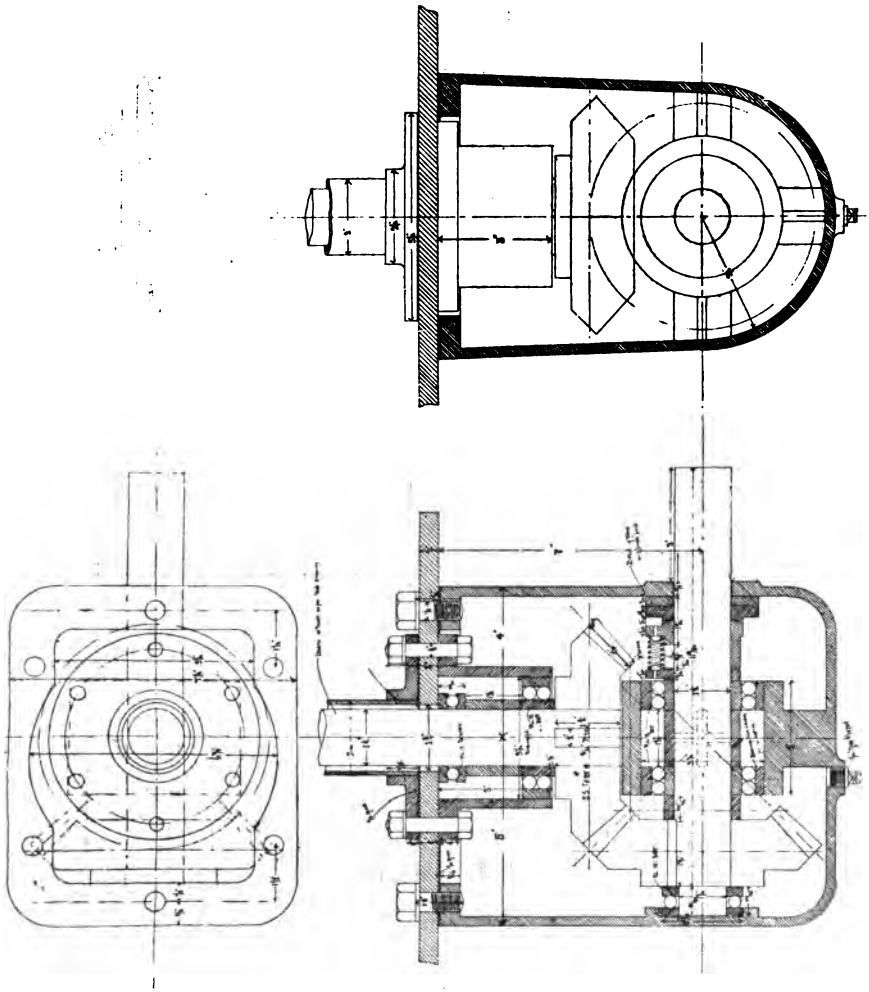


Fig 5.—Details of Paint-Proof Bearings and Gear Box.

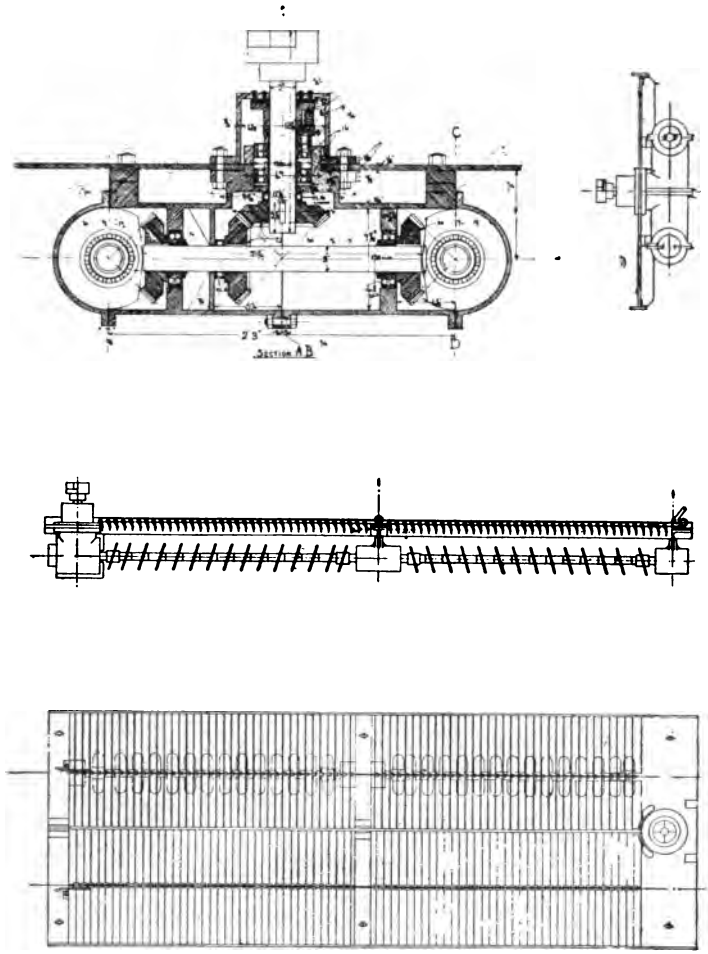


Fig. 6.—Details of Sub-frame, Shafting and Driving Gear for Tank Designed for Implement Manufacturers.

as to prevent excessive evaporation and also for use in case of fire. These doors or covers should therefore be actuated by levers or other suitable appliance which may be put in motion at a point some distance from the tank itself, for while the paint is not very liable to catch light, an accident may cause it to do so, particularly when electricity is used in the works, and the closing of properly constructed doors will quickly subdue fire as far as the tank itself is concerned by shutting off access of the air. The usual plan followed is to provide wide strips of thick felt attached to the doors in proper position so that when the doors are closed the contact will be thorough and the tank itself be practically sealed.

When agitators form part of the apparatus it is not necessary to buy the paint ready mixed for use, as it may be introduced into the tank in thin paste form; the necessary thinners such as white spirit can be added and the agitating apparatus slowly revolving will quickly mix the parts together and render the paint suitable for use.

It will be understood that the form of tank above described may be very considerably modified according to circumstances. In very simple paint dipping, such as is required for small articles, casements, etc., the agitating apparatus may be wholly dispensed with, while in other cases, the shutter-like arrangement above mentioned may be omitted and the agitator may consist of a worm with a screen above to protect the parts from pieces which may accidentally fall in.

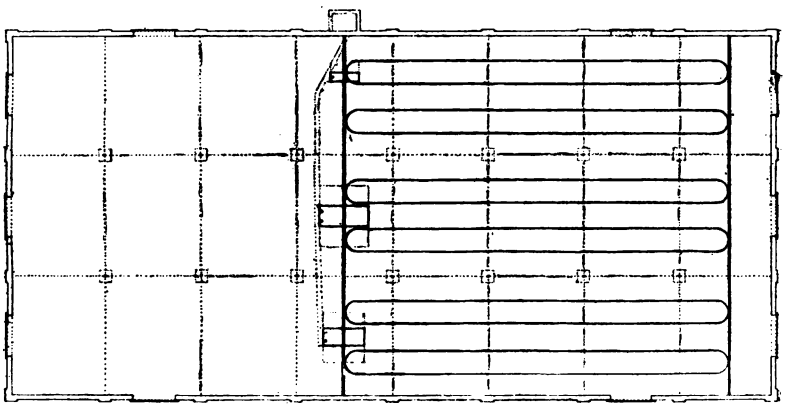
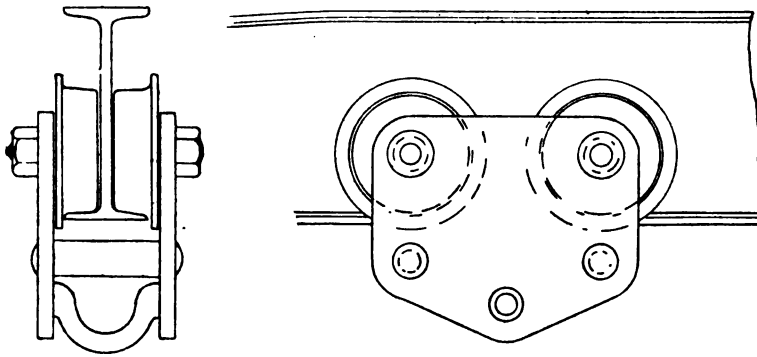


Fig. 7.—General Lay-out of a Three-tank Plant Designed for the Use of an Agricultural Implement Maker, Using Three Colours in this Instance, Red, Green and Blue.

The Rails and Hanging Apparatus.

These two details may be conveniently considered together, and it should be stated at once here again a great deal of difference of opinion exists as to what system is the best. It should, however, be clearly understood that upon the system of railing a great deal of the success depends. The object, of course, to be attained is that of handling a arge number of parts with as little labour as possible. With this object, a complete system of overhead rails, commencing with the finishing shops, leading to the paint tank, and thence to storage or delivery departments, should be carefully thought out, always remembering that the growth of a business may necessitate the erection of additional buildings from time to time and provision made accordingly. One of the



Cross Section. Side Elevation.

Fig. 8.—Joist and Wheels Supporting Hanger.

simplest and best forms of rails is an H section joist with two wheels on either side as shown in Fig. 8. In other cases an L rolled joist is used, the railing part being on the vertical flange while the horizontal flange is connected with rods fixed to the upper part of the building. One method which is used quite successfully is to employ hooks as shown in Fig. 9. These run over rails which are lubricated with vaseline, and in this case the rails are usually slightly inclined. In very large works, however, where a considerable length of rail is employed this inclination might be inconvenient, as the rails would go too near the ground. In all cases horizontal rails are found in practice to be the most convenient, but an installation requires careful consideration from all points of view and no general rules can be laid down.

Hanging after Dipping or Spraying.

A practical point of more importance than might be supposed, at first sight, is to avoid hanging articles very close together after they have been painted or enamelled, either by dipping or spraying. The reason is that if they are hung quite close together the turpentine or volatile thinner used in the paint may affect part of the adjacent surface, and cause a diminished gloss.

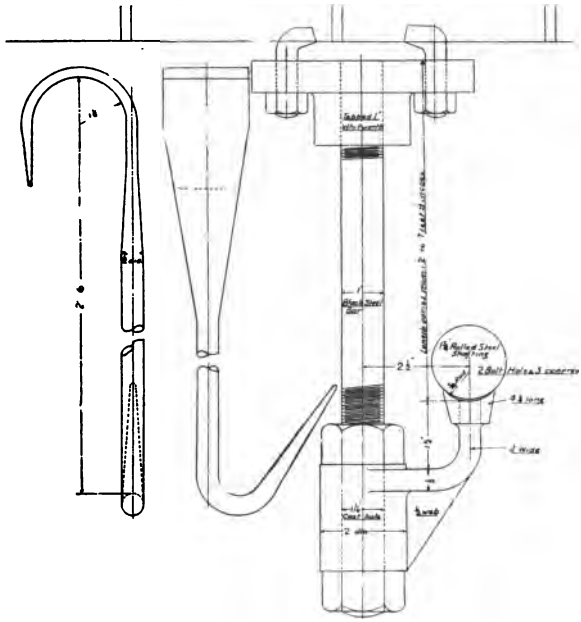


Fig. 9—Hook for Hanging.

This point was brought to light in the case of one manufacturer who was painting varnish cans by dipping. They were hung up to dry quite close together—in fact, almost touching. When dry, it was noticed that, instead of being nice and glossy all over, one side was somewhat dull. The explanation appeared to be that the turpentine fumes affected the paint in drying, and this was proved to be true, as when the cans were placed farther apart the trouble ceased.

Hoists.

The hoists used will depend upon the size and weight of the objects that are to be dipped. In some cases they may be dispensed with altogether and the dipping can be done by hand.

In cases where the space is confined, it is sometimes desirable to use hoists in the form of wall crabs, and a few

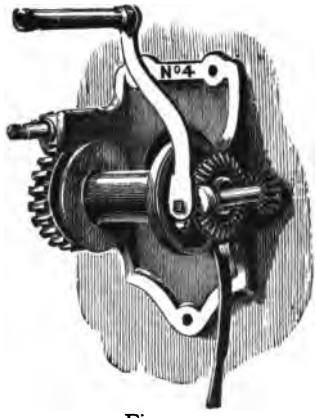


Fig. 10.

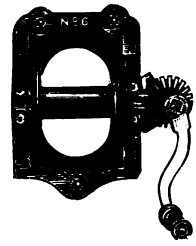


Fig. 11.

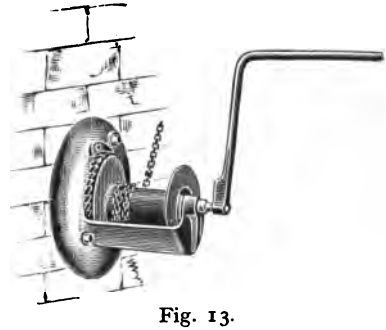


Fig. 13.

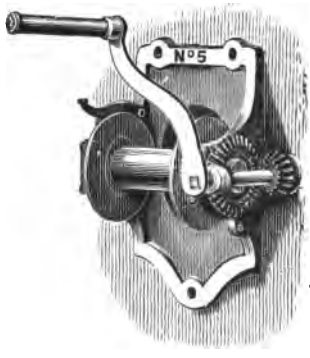


Fig. 12.

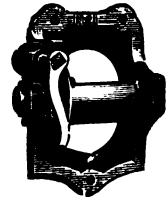


Fig. 14.

of these made by the London Hoist Machinery Co., Ltd., 103, Worship Street, E.C., are illustrated in Figs. 10 to 14. The hoist shown in Fig. 10 will lift 10 cwt. with slow speed on the left-hand side, and 3 cwt. on the right-hand side with

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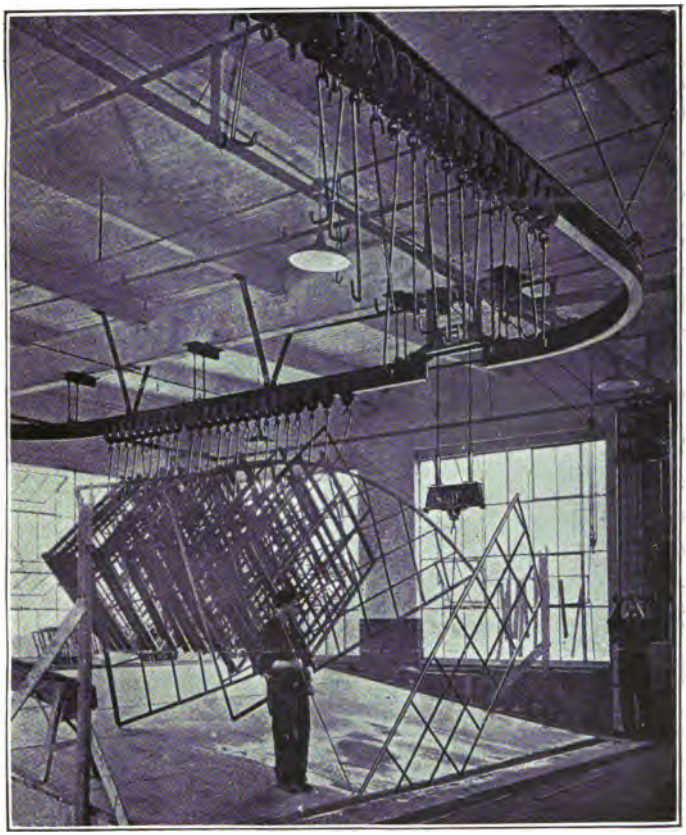

Fig. 15.—A Typical Hoist for Use in Painting by Immersion.

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a quick speed of 13 feet per minute. This form can be made lower by brake if desired. The little crab shown in Fig. 11 deals with weights of 1 cwt. at a speed of 60 feet per minute, while that shown in Fig. 12 is also a quick gear, lifting 3 cwt. at 13 feet per minute. The other illustrations are self-explanatory.

Fig. 15 shows a typical hoist which may be regarded as an ideal installation for the work, and the idea can be adapted to either large or small works as required. The installation consists of an overhead track with a movable portion over the dipping tank. The goods to be dipped are hung on the trolleys and run one by one on to the movable portion of the track over the tank. There is a stop on this portion to prevent the trolley running right over the tank, and the movable portion with the article to be dipped is lowered into the tank, and afterwards raised by means of a hoist. The hoist in this case was driven by pneumatic power. It could, however, in very small installations be a hand hoist worked by the rotary movement of a handle, or in other large installations a quick moving electric hoist.

After the article is dipped and the movable portion raised by the hoist to its correct position in the track of the runway, the trolley is run off the movable portion on to the track beyond the tank, and left there to dry.

These overhead runways can be made to suit loads from 2½ cwts. up to 10 tons, so that the system covers all classes of work, since it is seldom that it would be necessary to dip articles weighing more than 10 tons.

Fig. 16 shows a Morris standard electric trolley hoist suitable for lifting up to, say, 5 or 6 tons. Both of the foregoing hoists are made by Messrs. Herbert Morris, Ltd., of Loughborough, to whom the author is indebted for these illustrations.

In Fig. 17 is shown another type of trolley hoist suitable for lifting heavy weights.

The number of Coats of Paint to be Given.

An important consideration both in paint immersion and paint spraying is the number of coats of paint which should be given in order to produce the required appearance and ensure durability. This must necessarily depend upon the use to which the article to be painted is to be put, and it will also depend upon the appearance. In paint spraying it is clear that any thickness of paint required could be obtained by continuing the operation of spraying, but it has been found in

practice that it is not desirable to continue the application of the paint beyond the point when every part of the surface is completely covered. It is a well-known fact that three thin coats of paint applied separately will prove more durable than two thick coats, even if the quantity of paint used in the two cases is identical. The same is true to a great extent when the paint is sprayed on. When it is applied by dipping another important element enters into consideration, and that is, thin coats are a practical necessity, because if an attempt was made to make the coat thick it would inevitably result in unsightly runs, fat edges, etc., which would wholly spoil the work. Where the object is only that of a temporary protection, as in the case of iron castings, a single coat will usually suffice, because the castings when fixed in position will be painted with the building in the ordinary way.

Sometimes a priming or first coat of paint is given by dipping, and the following coats are applied by brushes or by spraying. There appears to be some idea that when paint is applied by brushes it is forced into the pores of the wood and therefore holds better; as a matter of fact, in a well-designed paint the thinners will penetrate the wood and no particular force is necessary; but if it should be, it will be certainly supplied by the spraying process.

Advantages of the Dipping Process.

The advantages of applying paint, japan, enamel, or varnish by the process of immersion are obvious. The saving of time is the chief advantage, and this will be in most cases very considerable. For instance, a complete wagon can be painted by dipping in a very few minutes, while large and intricate agricultural machines may be painted in the same way in a fifth part of the time it would take to spray them, and probably a twentieth part of the time it would take to do the work by hand.

There is another advantage which should be mentioned when paint dipping is compared with spraying. In the latter, an outfit consisting of sprayer, air compressor, exhaust, cabinet, etc., are all necessary. In dipping, however, the apparatus may in many cases be of the simplest character. For example, in painting bedsteads all that is necessary is a narrow but deep tank containing the paint, into which the bedstead may be plunged by hand and then hung up to drip over a metal-lined floor.

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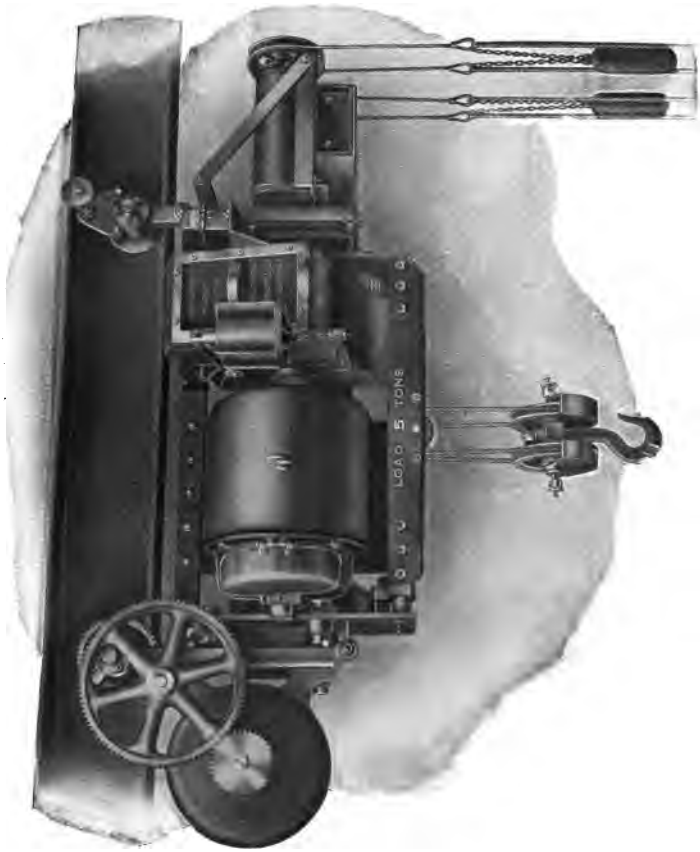

Fig. 16.—A Morris Standard Electric Trolley Hoist.

In Birmingham, hundreds of iron bedsteads are dipped in this way every day. The head or foot of the bedstead is taken in the two hands of the operator, dipped into a tank of black japan, and immediately hung up on a travelling chair, which slowly carries it across the room to the oven, the superfluous paint dripping off during the process.

In another chapter will be found the advantages which the process of spraying has over dipping. A decision as to which is the best system to adopt for any particular purpose can only be determined after due consideration has been given to all the circumstances bearing upon the work to be done.

It may be pointed out in this connection that the process of painting called "flowing on," which is fully described on another page, is in effect only a modification of dipping. As a motor body, for instance, cannot be plunged into a paint tank because the inside is not to be painted, the paint is literally poured over the surface, and the effect is exactly the same.

Protecting Parts Not to be Painted.

It frequently happens in paint dipping that certain parts of a machine or other article that is desired to be coated with paint is to be left unpainted, and the problem is how to effect this most economically. The method usually employed is to cover the parts, such as name plates, bright portions of a machine, etc. with vaseline. When the article is dipped the paint covers this as well as the other parts, and after the paint is dry the vaseline and the paint on it can be easily wiped off and the surface beneath it will be found to be quite clean.

Preparing Woodwork Before Painting.

Previous to the priming coat of paint being applied to any article made of pine or other wood containing knots it is necessary to protect such knots by applying one or two coats of a liquid known in the trade as "knotting." If this were not done the rosin which exudes more or less from the knots would penetrate the paint, discolour it and give a very unsightly appearance.

The best knotting consists of shellac dissolved in alcohol, usually in the form of methylated spirits; in other words, it is shellac spirit varnish. Many inferior grades, however, are sold in which the shellac is adulterated with

rosin or other substances, while the alcohol is sometimes replaced wholly or in part with naphtha. These inferior qualities of knotting should never be used, as they are very likely indeed to cause trouble and spoil the whole job.

Although the parts of machines such as agricultural implements are usually made of selected and well-seasoned timber, it sometimes happens that portions of the work are found to be more or less sappy. This should also be coated with knotting, as otherwise they will absorb the paint to too great an extent and the priming coat will not be uniform.

In passing, it may be observed that a coat of shellac varnish—a term, as already explained, which is synonymous with knotting—is very useful as an undercoat whenever there is an excess of rosin as in pitch pine. It is also used to stop suction on plaster ornaments which are finished in imitation bronze, and which may successfully be used over tar or tar spots which it is desired to paint.

It is very important that knotting be applied in quite thin coats, and it is for this reason that usually two coats are given. If it is too thick it fails to dry properly. Thick knotting may be used if it be well brushed out, but this is almost impossible in applying it to the knots of ordinary woodwork which are merely "dabbed" with the end of the brush ; moreover, such work is usually done by piece work, hence two coats are much safer to use.

Filler For Iron.

It is sometimes necessary before dipping or spraying cast iron work to fill up sand flaws and inequalities. This may be effectually done by using a filler prepared as follows : Mix together equal parts of genuine red lead and gilders' whiting and add two parts of boiled linseed oil and one part of goldsize. It will be found most effective to mix the two liquids last mentioned before adding them to the dry lead and whiting. Thoroughly mix all together, or, preferably, grind through a mill until the putty-like consistency is obtained. This stopping will dry very hard. It is important to remember that this filler must be mixed in small quantities as required as it rapidly becomes hard, so that if a considerable quantity were made at one time any unused would become spoiled.

Another recipe of an entirely different character for a cement or putty for the same purpose is made by mixing one parts of flowers of sulphur, two parts of sal-ammoniac and 80 parts of iron filings and making them into a paste with

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Fig. 17.—Electric Hoist Suitable for Heavy Goods.

water. By increasing the proportion of sal-ammoniac the setting is also increased.

Stopping Holes in Woodwork.

However carefully a piece of woodwork may be prepared, there are usually more or less depressions or holes such as those which occur over countersunk nails, and in other places which require to be filled up. The usual stopping for this purpose employed by house painters is a mixture of equal parts of dry whiting and dry white lead, made in the form of putty, with raw linseed oil to which, say, 10 per cent. of boiled oil has been added. A cheaper and quite as effective a stopping, however, can be made by using a material known as "Alabastine," which possesses the advantage of being easily cut down. This material may be also used when mixed to a thinner consistency for priming, but it is not suitable for being applied by dipping, although it may be sprayed. The very best stopping is one such as is used by carriage painters, and is strongly recommended for high-class work. It is supplied both in powder and paste form by all first-class varnish manufacturers, and although the cost is a little higher than that of stopping putty made of whiting and linseed oil, as described, it is well worth the difference.

An excellent filling composition for coach and motor body builders, railway and tramway carriage manufacturers, etc., is that made by the well-known varnish house of Messrs. Wm. Harland & Son, Merton, S.W.

It is especially suitable, obtaining a perfectly level and unyielding groundwork where a fine finish is to be given, either in paint, varnish or enamel. It is made in two colours, grey for dark work and cream for light colours or white, and costs sixpence a pound, or less when bought in quantities.

It effects a great saving of time and labour, being already finely ground into a stiff paste, which only needs the addition of specially prepared thinners to bring it to a proper consistency for use with the brush.

It is most successful and expeditious as well as the most economical process for giving a smooth surface to rough castings—a condition which is, of course, indispensable when these have to be painted and varnished.

For ordinary surfaces of woodwork of a slightly rough or uneven character, two or three coats of the filling composition will suffice to produce, when carefully rubbed down, a per-

fectly smooth surface of a hard metallic nature, combined with great tenacity and durability.

"Philorite" is another speciality which may be mentioned in this connection. It is manufactured by Messrs. Wilkinson, Heywood and Clark, Ltd., and is a filler made in white and seven colours. This is a great advantage when the finish is to be coloured, as it may save a coat of paint. It can be rubbed smooth without difficulty, and will serve as a perfect ground for enamels and japans, as well as for paint. For use it is thinned out with American turpentine to the required consistency, say, that of a ready mixed paint. It is brushed on with a stiff bristle brush, and two coats may be safely applied on one day. The last coat can be rubbed down smooth with pumice and water or sandpaper. It may also be used as a knifing paste for defective surfaces.

Rubbing Down.

In many cases the coats of paint, japan or enamel have to be rubbed down between coats in order to produce a perfectly level surface. This is usually done by means of finely powdered pumice stone and water. and it is important to remember that the operation must be done with care so that the rubbing is quite uniform. If a slight gloss is given to the paint the portions which are rubbed down can readily be discerned, as they will have a gloss, and in this way uniformity can be ensured. It is of the utmost importance that all of the powder be washed away before the next coat is applied; if any is left it will mar the job. It may be noted that the work of rubbing down may be done more expeditiously by means of the finest grade of steel wool. On the Continent this is now used exclusively, and it is rapidly gaining favour in Great Britain.

Fig, 18.—Sprayed Show Card.

Fig. 19.—Dipping and Stoving Bedsteads.

CHAPTER III.

Requirements of Different Trades.

The following are a few of the special requirements of different trades as to paint dipping. The details might be lengthened almost indefinitely,

Bedsteads.

The methods adopted for the class of work will, of course, depend upon the quality of the finish required. Cheap bedsteads may be done by dipping in one coat of black japan and stoving at 350° F. In better class work several coats may be applied either by dipping or spraying, and each may be rubbed down after stoving. If a good enamel is used this is unnecessary.

When the work is white several coats—say, at least three—are necessary, for white japans cannot be made which will cover sufficiently in one coat. White lead should not be used in this class of work for the reason that a good deal of handling of parts is necessary, while the rubbing down is sometimes done with glass paper and cause dust, both of which may give rise to lead poisoning. All of the best white japans or enamels are made on a base of zinc oxide or lithopone (zinc sulphide), or a mixture of them.

Collapsible Gates.

This work is usually done by dipping in paint which dries "flat," i.e., without gloss. The colour is, as a rule, black. In fitting and adjusting the work in order that the parts will collapse readily it is necessary to apply a lubricating oil where the rods meet. This lubricating oil is difficult to remove after the adjustment has been completed, and therefore the last coat of paint is usually put on by hand. It is suggested, however, that raw linseed oil might be used

instead of lubricating oil, and that this could be wiped off as soon as possible after the adjustment. In such a case the paint could be applied by dipping, as if even a little of the raw linseed oil were not removed it would not interfere with the drying of the paint to any material extent.

Dipping Sewing Machine Parts.

The process employed by a very large firm of American manufacturers is as follows:—

When the castings come from the machine shop they are boiled for 20 minutes in ammonia water to kill the grease (1 of strong ammonia to 20 of water), and are then rinsed in hot water. Any holes or inequalities in the castings are then stopped with a filler made from dry white lead, mixed into a stiff paste with some varnish, brown japan dryers and dry lampblack made quite stiff. When the stopping is hard the castings are dipped into a black metallic coating thinned with 62% benzine to a specific gravity 850. They are then dipped with two coats of finishing japan (sp. gr. 830) flatted with powdered pumice after each coat and leathered off. The parts which are not plated or flatted are given 5 hours' stoving at 325° F., and are then rubbed with pumice and carpet pad until flat. Cut out gold transfers are then fixed with transfer varnish and the work is stoved at 185 F. The parts are then sponged and dusted, and are given a good coat of polishing varnish (sp. gr. 950°). Finally the work is rubbed down fine with glass paper and pumice powder and then polished with machine oil and rottenstone powder for the iron, or rottenstone and benzine for the tables. The latter, as well as the covers for these, are not usually dipped but brush finished.

Iron Rods

In most cases, iron and steel rods are best painted by immersion, as the small surface presented would cause too much waste if spraying were attempted. As in most cases of dipping, success depends largely upon the means adopted for handling and dipping a number of rods at one time. Frequently, stoving is required to harden the japan, because a rod is often subjected to considerable wear. Perhaps the best plan to adopt, where the number of rods to be treated warrants the outlay, is to provide mechanism by which the rods are dipped and are at once automatically carried into a

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Fig. 20.—Immersing Mangle Frames.

stove, and by means of slowly travelling chains, carried out at the other end.

An excellent contrivance for the purpose is in use at the Ford Motor Works, at Manchester. This consists of a vertical oven, heated by gas, and having slowly-moving endless chains running from bottom to top and down again to a point where the rods are discharged on to inclined runners. These rods are passed through a bath of japan, are then taken up by the chain, and, during their progress, are baked. A gear is provided by which the time between the entry of a rod to its discharge may be varied from twenty to ninety minutes, or any period between, according to the purpose for which the rod is to be used and the degree of hardness of the japan required.

Iron Window Frames or Casements.

A long narrow tank, say, from 1 foot 6 inches to 2 feet wide and 15 feet long, is suitable for this class of work, which is usually done in one coat only, and this is quite sufficient to protect the iron until the casement is fixed in position, when it will, of course, receive additional coats by means of a brush in the ordinary way.

It is important that the iron be dipped just as soon as it leaves the finishing shop, and it is necessary that the surface be thoroughly cleaned before the paint is applied, and particularly after all scale is removed. Sometimes the application of the sand blast is necessary for this work, but, as a rule, a vigorous application of suitable wire brushes will suffice.

Another very important provision is a system of overhanging rails on which the sashes or other articles can be run direct from the finishing shop to the paint tank, and thence to any part of the building, from which they may be taken as required for shipment.

The paint used for casements is usually grey, being as a rule made of zinc oxide and lampblack. These pigments, when mixed with a suitable vehicle, are very durable, while, the colour being neutral, it is suitable as an undercoat for green, as well as nearly any other colour which it may be desired to use as a finish. The weight of the paint should be 13 lbs. to the gallon, and it should dry with a semi-gloss. The elevating apparatus need only be of a simple character, and several casements can be suspended and dipped at one time. For this purpose a "hanger" is used, having perforations through which one end of the hooks pass. One form is

shown in Fig. 21. By the side of the tank should be a large metal lined floor, say, 20 feet by 15 feet, or even larger, inclined toward the tank. The frames having been plunged

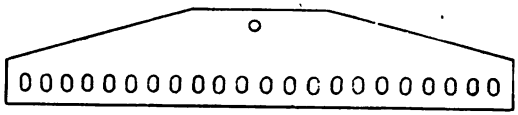

Fig. 21.—Iron Hanger for Suspending Several Articles to be Dipped Together.

into the paint, are at once withdrawn and hung in rows to dry over this floor. The superfluous paint drips on to it and runs back through a screen or sieve into the tank. The latter should be provided with a cover, to be closed in when the work is not being proceeded with.

In this class of work it is unnecessary to employ a stirring apparatus provided that the paint is of the right consistency, and an occasional stirring up with a pole after the work has been suspended, say, for example, from Saturday to Monday, will usually be all that is required. As a matter of fact, the lowering and raising of the casements into the paint effectually stirs it up.

Metal Furniture.

Under this head it is intended to include such articles as deed boxes, lockers, files and other metal goods which are required to be painted both inside and out. An enamel stoving or baking paint is usually employed for the purpose, while the tank must be of sufficient size to accommodate the various articles that are to go into it. Taking a deed box by way of example, a large iron hook, such as is shown in Fig. 32 is placed inside the box so that it is suspended at an angle; the box or boxes are then lowered into the tank and immediately withdrawn after all the superfluous paint runs away, care being taken that the box hangs at a proper angle to permit of this being done. Great care must be taken in this room to exclude all dust, which would considerably mar the work. For this purpose wire netting of the finest mesh should be placed over the windows so as to screen off any dust which might otherwise enter. A system of overhead rails are made, consisting of an L-iron on the top side of which run two rollers to which are attached

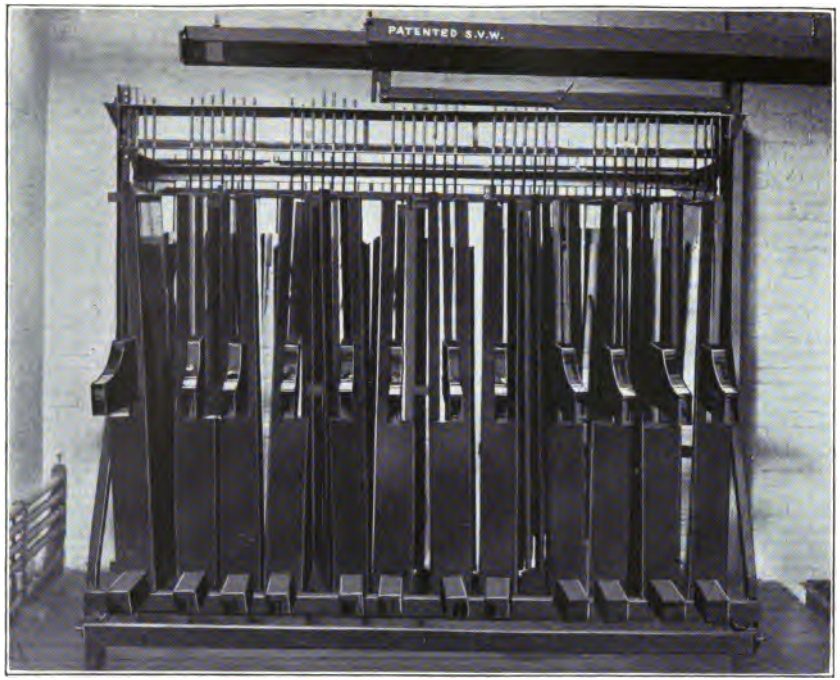

Fig. 22.—The Automatic Finishing of Pianos.
Carrier Filled with Six Complete Pianos.

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ANNEXATION

hanging gears, and is sufficient for the purpose. At least ten minutes should be allowed for these articles to drip over the inclined floor adjacent to the tank, and for safety's sake it is as well to employ a workman with a brush in his hand to go over each piece and remove any tears or runs which may possibly occur. Metal work of the description named is then placed in a stove and baked for three hours at a temperature of 400° F. The paint is frequently green, which is found to be a good serviceable colour and which is attractive in appearance. After the baking the paint is quite hard, and will withstand more or less rough usage. If any ornamental work is required, this is done afterwards, as explained under the head of "Stencilling." The paint employed weighs 13 lbs. to the gallon, and a fine mesh paint strainer must be provided, through which the superfluous paint passes as it drips from the articles on their way to the tank. In this case, as in others, no special stirring apparatus is required, as the comparatively heavy vehicle and the relatively light specific gravity of the pigment employed gives little or no opportunity for any "settling out."

Motor Parts (Metal).

The various parts which go to make up a complete motor car are differently treated according to their shape and size. In most cases, stoving is resorted to, because the enamel or japan is thereby much increased in durability by the hardening which takes place in consequence of the high temperature.

The steel rims of wheels are dipped by hand into a black japan made especially for the purpose. They are hung on hooks and allowed to drain for some minutes, and are then transferred to the stove, where they are subjected to a heat of 320° F. Such parts as ribs, front and rear wings, running boards, shields, etc., are dealt with in the same way.

Previous to dipping, these parts undergo the process known as "pickling," by which scale, grease, etc., is removed so that a perfectly clean surface is presented to receive the japan.

Troughs to catch the drips must be provided, and it is essential that these be kept quite clean, so that the superflous japan may run through gauze and be pumped back again into the tank to be used again.

Automatic Finishing of Pianos.

The Standard Hydraulic Immersion System.

Any doubt as to the perfection of finish which may be produced by a carefully thought out system of immersion or dipping must be removed by the fact that such a system has been in successful use for some years for the finish of pianos. It need hardly be pointed out that such a finish must necessarily be so well done as to approach perfection.

One firm has made a special study of this subject, viz., the Standard Varnish Co., of London and New York, and their efforts have been most successful.

By this method an absolutely even distribution of varnish is always secured; no part of the piano case is neglected and an enormous reduction in the cost of varnishing is effected. The factory output can be readily increased as desired, as the varnish working force of the factory can do as much or as little work as trade conditions may demand.

The mechanical details have been so perfected that every kind of instrument can be handled satisfactorily.

The excellence of the finishing done in accordance with this system is attributable to a large extent to its mechanical construction. The apparatus used in connection with the Standard method of piano finishing consists, in the first place, of a steel tank for the varnish with an adjustable cover which can be locked when the apparatus is not in operation, a hydraulic lift for raising the work slowly out of the varnish, a small horse-power pump which is operated either by steam pressure or compressed air, and in extreme emergencies where the pressure is not adequate for heavy work, a small motor for operating the pump.

There is also installed an apparatus similar to the automatic sprinkler system. A fusible link or another mechanical device makes it possible to draw off the varnish into a tank outside the main buildings at will, and for protection in case a fire should take place in any other part of the building.

The principal investment for the piano manufacturer is the carriers or racks for holding the separate pieces. The cases are held firmly in the carriers by means of springs which are adjusted for the introductory carrier, or secured by screws in the permanent carrier which is designed for keeping the cases in the carrier until they are ready for rubbing. This latter method saves the labour of handling.

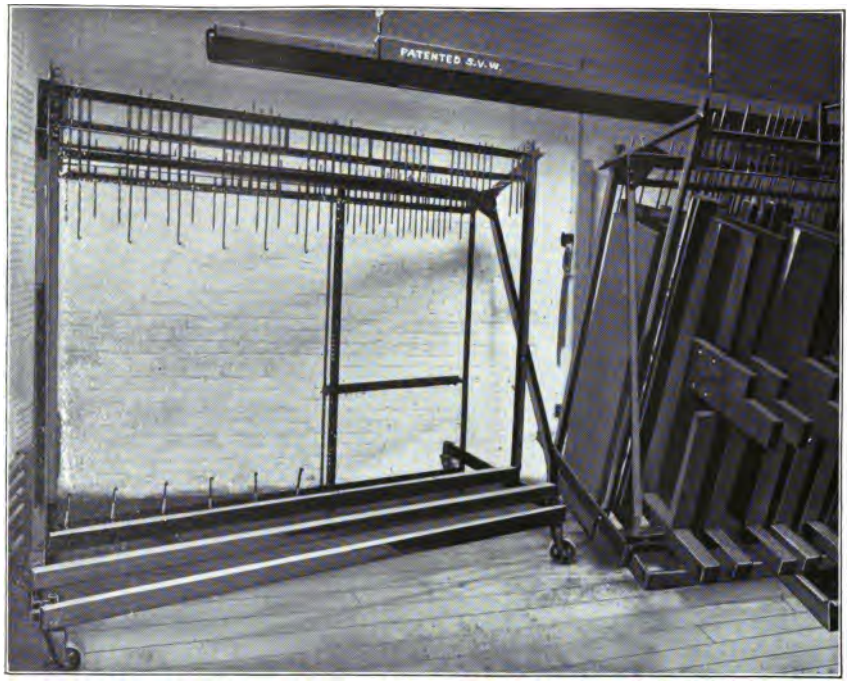

Fig. 23.—Automatic Finishing of Pianos.
Introductory Carrier ready for Parts to be Varnished.

Carriers filled with work to be varnished are raised from the floor, swung directly over the tank, and lowered into the varnish by means of an hydraulic lift. The speed with which the work is raised from the varnish is controlled by a lever conveniently located for the operator.

Once the speed has been determined and the lever set the apparatus requires merely the supervision of an operator, who may devote considerable time to helping his assistants reload another carrier while the one in the tank is emerging. Generally only a limited number of carriers are required.

When the work is to be removed between coats a large percentage can be handled without tack in a short time after it is taken from the varnish.

In the introductory carrier, parts like piano tops, which are finished on all sides, require a little additional care because of the difficulty of handling. This contingency is provided for by the use of special head pieces.

In emergencies, for rushing out an extra quantity of work, carriers holding falls, frames and small parts may be immersed in one-half the interval usually required.

For example, these carriers can be withdrawn in from fifteen to twenty minutes, whereas for carriers including sides from twenty-five to thirty minutes are required. The carriers are equipped with head pieces adjustable to meet all peculiar local factory requirements. In fact, these carriers can be constructed by the manufacturer to meet all his demands.

The number of carriers necessary depends entirely upon the volume of work to be handled. But it is desirable, when possible, to have a sufficient number of carriers to hold all the work until the varnish is sufficiently dry for rubbing. In this way a tremendous amount of labour and time is saved.

Permanent carriers, in which the work has been secured by ordinary screws, have been constructed by some manufacturers at an unusually low cost by their own machinists in their own factories.

The work in the carriers can be easily dusted by means of air-bellows or a compressed air-blower. Work finished in this manner is so clean that the usual sanding is not necessary and a considerable amount of labour thereby saved,

That the Standard hydraulic immersion system of automatic finishing of pianos has distinct advantages over the ordinary hand process is obvious even to the casual observer. Among the numerous advantages which have

been effected the following seem to be worthy of special consideration:

It constitutes practically the factory's entire varnishing force.

Its use insures an even coat, free from imperfections.

Coating both sides of the work preserves the cases considerably from shrinking and warping. A great deal of labour is saved by varnishing both sides at once.

It requires very little more varnish than the old, slow, hand method as there is no waste from brushes and pots and absolutely no dripping outside the tank.

The elasticity of the Standard system of piano varnishing eliminates the necessity of additions and reductions to the working force.

The cleanness and evenness of the finish virtually makes every coat a flowing coat. The amount of time and effort saved in the rubbing and polishing is tremendous, and the finish obtained is much finer, due to the absence of uneven coating and the blemishes of pinholing and dust.

Carriers containing six complete pianos each, at an average interval of one half-hour, will enable the factory to turn out 108 pianos with one coating during a nine-hour working day.

Carriers containing eight complete pianos would handle 144 pianos a day. A lift sufficiently strong to accomplish any demand placed upon it can be installed to immerse as many carriers at once as will be necessary.

A smaller carrier containing four pianos can be installed for the manufacturer with a small output of pianos, which by the very nature of its construction is handled more readily than the larger carrier.

In coating both sides of the work a decided protection against shrinking and warping has been provided. In fact many manufacturers are taking this precaution by brushing both sides of the work. By the Standard method the work is automatically coated on both sides at the same time.

Very little more varnish (not more than 5%) is required by the Standard system than by the hand method. The inventors' own experiments, as well as the daily use of the system by manufacturers, shows that more varnish is wasted about the varnishing room than is required by the immersion system to coat the unfinished side of the work. With this method, all of the small amount of varnish that drips off falls back into the tank.

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Fig. 24.—Lowering Piano Cases into the Varnish Tank.

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Fig. 25.—Piano Cases nearly Immersed.

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Fig. 26.—Piano Cases wholly Immersed.

One of the most difficult tasks of the finishing room foreman is to be certain that the proper reduction is made for the first and other undercoats. This is entirely eliminated with the use of the Standard system of piano finishing. This process alone makes it possible to apply a minimum quantity of varnish sufficient to withstand the strain of rubbing and polishing. This lessens the possibility

Fig. 27.—Piano Cases about to be Dipped.

of shrinking and cracking which excessive varnish coats applied by brush involves. The slower the speed of the lift, the less varnish is applied to the work, consequently there is a gradual regulation of the amount of varnish for the separate coats.

The foregoing description, together with the accompanying illustrations, will enable the reader to understand the general method adopted. It should be added that it is applicable to many other articles besides piano cases.

The system described was invented and is controlled by the Standard Varnish Company of London and New York.

Wheels.

An extremely ingenious but effective machine for coating hickory wheels with paint or japan is in use at the works of the Ford Motor Company, Trafford Park, Manchester. It consists of a stationary cylindrical vessel of exactly the right size to receive a wheel, which, being placed in position, is at once lowered into a tank containing the japan. Here it is made to revolve very rapidly, by which means the japan is thoroughly distributed over every part. Hickory, being a hard and comparatively non-absorbent wood, the japan might give too thick a coating if dipped and left to dry in the ordinary way. To prevent this, the wheel, while still revolving very rapidly, is mechanically lifted out of the japan, and is held just above it, where it continues to spin. This has the effect of throwing off the superfluous japan by centrifugal force. The cylindrical sides of the apparatus catch the japan, and it runs down into the tank below. The wheels are then taken out by a man, who wears gloves, are stacked on edge in rows to dry, and, after an hour or so, they receive a second coat. After twenty-four hours, or less, they are ready for use.

The advantage of rapidly revolving the wheels is that anything in the nature of a drip is entirely eliminated. This machine can deal with 300 wheels an hour, so rapid is the process. At the present time the Ford Works are using 2,000 wheels a week.

Some Typical Plants.

In gathering information of up-to-date character to include in this book the author has visited various parts of the country, and through the courtesy of the firms mentioned below has examined the plants used successfully for the treatment of many different goods. The following is a brief description of some of the plants inspected, although it by no means exhausts the list :—

Carriage Department, Woolwich Arsenal.

The plant for painting wagons, etc., has been in use for about 12 years and has been eminently successful, it being found by experience that a paint applied by dipping proves equally durable to that formerly applied by means of brushes. Indeed, the durability is increased for the reason, which has been pointed out elsewhere, that the paint finds it way into open joints and crevices which could not

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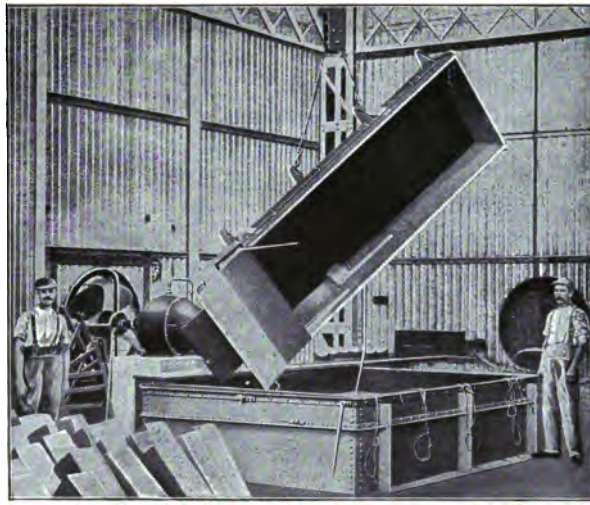

Fig. 28.—Dipping a Coach Body at Woolwich Arsenal.

Fig. 29.—General View of Paint Dipping Room at Woolwich Arsenal

be reached by a brush. In some cases a wagon is dipped bodily, while in others it is dismantled and the different parts are dipped separately; again, the smaller portions are placed in an open wire basket which is plunged into the paint. The building in which this painting is done is of considerable extent and a large paint tank is located at each end. A wagon on being completed, or in the case of an old wagon, after having been prepared, is brought to the first tank and is raised from the ground and lowered into the paint, where it remains for about half a minute. It is then immediately raised, allowed to drain over a tank for a few minutes, and then over an inclined floor for a further period. At the end of about half an hour a workman inspects the wagon or other article and removes any tears or runs which may have occurred. The paint being specially prepared this is not usually an arduous undertaking.

The illustrations show very clearly a coach body in process of dipping. Overhead rails run throughout the length of the building and upon these are suspended the painted wagons, which are gradually moved along with a very little exertion, such rails being slightly inclined to facilitate this. By the time the series of wagons reach the further end of the building they are ready to receive a second coat of paint, by being dipped in the second tank. This being done they are then moved back, being at once suspended on the rails until quite dry, when they are hoisted to the upper part of the building, where they are left suspended until they are required for use. The paint is, of course, a special one which is supplied in paste form having the necessary binding ingredients. The colour used is khaki, which is very durable, being composed of earth colours. The thinning is done on the premises and white spirit is employed for the purpose, not turpentine, which would be far too expensive. Formerly benzine was employed, but this necessitated the use of a fan to take away the fumes which came from the spirit. Such a fan is not now found to be necessary.

The tanks are fitted with iron covers bearing upon thick felt and are operated by means of levers placed at a distance, so that should a fire occur they can be closed at a moment's notice. The hoist is worked from the ground by electricity. Formerly the operator of the hoist was located in a cab near the roof, but it was felt that this would be a dangerous position in case of fire, and he now, as stated, does the work from the ground. The work done at Woolwich gives an excellent example of the actual saving which may be effected by

using the paint dipping process. Before the painting plant was put in no fewer than 200 painters were constantly employed; now about 40 are fully able to turn out the same or even a larger number of wagons in a given time.

James Gibbons.

Most of the metal sheets as well as finished metal work of various kinds made at these extensive works at Wolverhampton are finished by dipping into special enamels or japans made by Messrs. Mander Bros. The dipping is done by hand and the pieces are placed at the side of the tank to drain. In some cases it is found necessary to go over the work slightly with a brush to remove tears, but such work takes only a few minutes and is used mostly as a precautionary measure.

One coat is usually found sufficient, and at the proper time the iron sheet or metal article is stoved at 250° F. to 300° F. for two hours. Many other articles are also dipped successfully.

Harrison, McGregor & Co.

In the extensive factories of this firm at Leigh, Lancashire, dipping by immersion has been successfully carried on for some years past. Various agricultural implements are dipped bodily in a tank of paint which is fitted with a worm agitator, and is of simple construction. The iron parts are dipped separately, being supported on suitable hangers, while the very small parts are placed in wire baskets for immersion.

Phillips and Son.

The paint dipping plant at these works, which are situated at Sherbourne Street, Birmingham, has been in successful operation for some years past and is applied principally to bedsteads.

The tank holding black japan measures about 5 feet by 18 inches and is some 9 feet deep. The bedstead head and foot are separately dipped by hand into the tank which contains black japan, and are immediately hung on a hook attached to a slowly travelling chain. This chain runs around a rectangular space, and beneath is a metal lined dripping floor. The stove is located diagonally from the tank, so that by the time the bedstead parts reach it the

dripping has ceased and they are ready to be baked. The stoving is done at 320° F., and is continued all night. One coat is found to be ample.

A very ingenious arrangement is in use for the application of coloured enamels. Three shallow tanks are mounted on rollers running in angle irons one above the other in such a manner that any one tank may be pulled out when required for use free from the others.

As a rule three coats are given for white work and two for green, blue and most other colours. No white lead is used, but only non-poisonous colours. The stoving is done mostly overnight at a temperature of 250° F. A little rubbing down between coats is done with very fine glass or emery paper. The japans are made by Messrs. Thornley & Knight.

In these works safes are painted, but the work is all done by hand.

The Ford Motor Company.

The extensive works of this company, at Trafford Park, Manchester, contain as complete a plant for painting, japanning, enamelling and varnishing, as it has been the pleasure of the author to inspect.

With characteristic thoroughness every detail which will ensure a first class finish with a minimum of time and labour has been thought out and applied. The result is that not only is every part dealt with most expeditiously but one coat of paint is applied to the whole outer surface of a motor body in the almost incredibly short time of two minutes. Further details will be found in this book under the heads of "Flowing-on," "Motor Parts," and "Iron Rods."

Marshall, Sons & Co., Ltd.

This well-known firm of agricultural implement manufacturers have a large dipping plant at their Gainsborough works, which they employ for painting various agricultural machines made principally of red wood. Some idea of the extent to which this process is applied may be obtained when it is said that on an average nearly 5,000 pieces pass through the dipping plant every month. The process is particularly well adapted for threshing machines and for appliances of the kind which consist of thousands of holes bored in the wood. If the painting were done by hand it would take many hours to paint such a machine,

while by dipping it is done even more effectually in a few minutes. The priming coat only is dipped after knots, etc., have been treated with shellac. The tank measures 21ft. long by 7ft. deep and 2ft. 3in. in width. An agitating apparatus is used and the lifting is done by pneumatic appliances.

Hayward Brothers and Eckstein, Limited.

The paint dipping plant in use at the works of this firm, at Union Street, Borough, S.E., is of a comparatively simple type, and consists of a shallow tank in which various cast iron and steel goods are dipped in horizontal position. As a rule, one coat of paint is given, but in certain cases two are required. The bottom of the tank is slanted, and the contents are stirred up from time to time, but no agitating apparatus is used. The principal goods painted by dipping are the frames of Hayward's lights, which are of cast iron and are dipped on one side only, the other side, after the glass is fitted, being done by hand. Metal casements are also dipped in considerable numbers, as well as treads and rises of circular staircases, straight staircases, balconies, etc. These, being made of ornamental open ironwork, contain a large number of small shaped holes, and the dipping process is found to be by far the most effective.

Another speciality of this firm are Hayward's patent steel collapsible gates. The first coat of paint is applied by dipping; this paint, being black, dries flat, i.e., without gloss.

The Crittall Manufacturing Co., Ltd.

These works are at Braintree, Essex, where a large amount of structural steelwork is produced, the chief manufactures being metal windows of all kinds, from the well-known steel casement and sash to metal windows for use in industrial dwellings and specially designed windows for various climates steel fireproof doors, skylights, steel office and works partitions, shop fronts; frictionless ball race runners for sliding doors, etc.

Perhaps the most noticeable feature of these works as far as our subject is concerned, is the very complete system of overhead rails, by means of which the various metal goods produced in the different finishing shops are conveyed to one or other of the paint tanks and then, having been left to dry, are taken to store rooms ready for instant shipment. These rails facilitate handling of the

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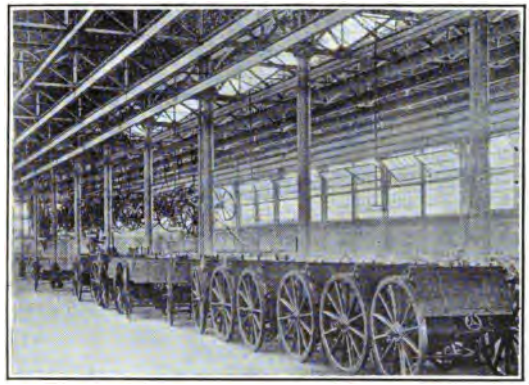

Fig. 30.—Wagon Store Room, Woolwich Arsenal.

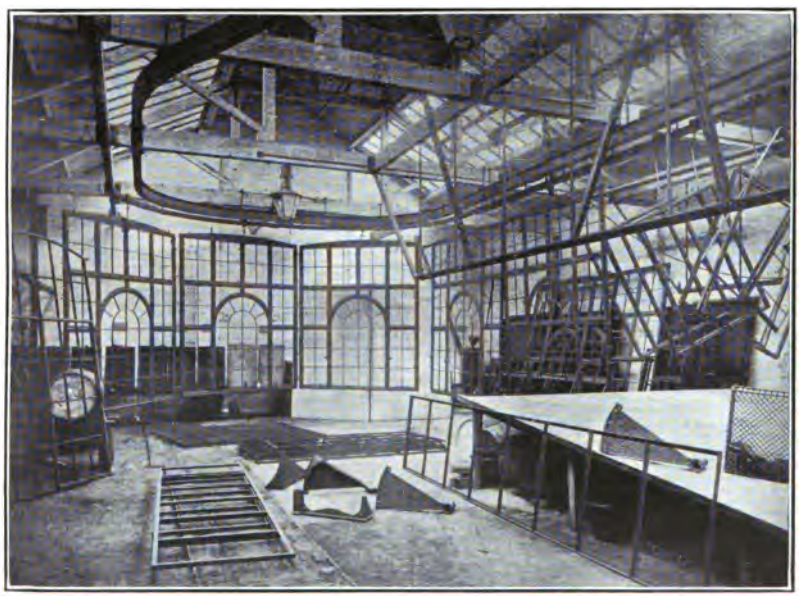

Fig. 31.—Dipping Casements at the Crittall Manufacturing Co.'s Factory, Braintree.

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various goods, and reduce the actual expenditure under this particular item to a minimum. The rails are L-shaped, the hanger used for each article or series of articles being of a simple character, consisting of two wheels bearing on the top of the upright flange, while rods secured by bolts pass through the horizontal flange and hold it in position.

We will first describe the tank used for dipping metal windows. This is 15ft. long by 12ft. deep and only 1ft. 6in. wide. Attached to the tank is a large dripping floor measuring some 15ft. by 21ft. covered with sheet iron and inclined toward the tank, so that the paint which drips on to it finds its way back into the tank through a grating provided for the purpose to take off any dried particles. The paint used in this work is made by Messrs. Docker Brothers, and weighs 13 lbs. to the gallon; one coat is found sufficient for the purpose. The sashes or casements being brought in from the finishing room on the overhead rail, they are lowered into the tank by means of a special lowering apparatus designed on the premises. Some idea of this may be had from Fig. 31. In order to keep the load steady during the time it is being dipped, a slight depression or dip in the rail is made immediately over the tank. The sashes are only left in the paint for a few seconds, and are then raised, allowed to drip over the tank for perhaps a minute or two, and then allowed to drip over the adjacent floor for perhaps a quarter of an hour or less. They are then taken farther along and the paint dries in about three hours. Sometimes two, four, six, or even eight casements may be dipped at the same time. Attached to the elevating and lowering apparatus are hooks which pass through one corner of the casements. This causes the parts to hang at an angle which facilitates running off of the paint.

We come now to the department in which the baking or stoving enamel is used as applied to metal furniture in general, as mentioned. In this case the articles are dipped in a manner very similar to that already described, excepting that a large hook, similar in shape to that shown in Fig. 32, is used to support the article to be dipped; the wide opening goes inside the box or file and holds it at an angle so that when it is lowered into the paint all parts are covered inside and out. A few minutes are allowed for dripping, and after two or three hours the articles are ready to be stoved. In this case, Messrs. Docker Brothers' standard colour, a very pleasing dark green, is used. The

stoving takes three hours at a temperature of 240° F., or higher in some cases. The tank mentioned is, of course, considerably wider than that used for casements. The dripping floor is in this case inclined toward the centre, which

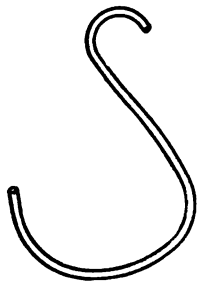

Fig. 32.—Hook Used for Suspending Metal Boxes While Dipping.

in turn is inclined toward the grating just outside the tank itself. If necessary, special thinners are added to bring up the gloss, but, as a rule, this is unnecessary. It is desirable after the article is dipped to go over it once with a small brush to remove any drips or runs which may possibly appear.

Another very important point to be attended to is to exclude all dust, and for this purpose the Crittall Manufacturing Co. have erected in this department screens of wire of the finest mesh over windows, so that no air can pass into the room without the dust being screened off.

Excluding Dust.

A matter of very great importance, yet one which is frequently overlooked in painting iron and other goods which are to have a glossy finish, either air dried or stoved, is to exclude dust from the apartment in which the work is done. In many engineering shops the nature of the business gives rise to a considerable amount of dust, and if this is allowed to enter the paint shop it will be fatal to the appearance of the painted work, as many specks will inevitably settle on the work and mar its appearance.

A paint shop is best provided with a concrete floor, and this should be frequently cleaned. The workmen should wear clean overalls, frequently renewed, and even so small a matter as keeping the hair, beard, etc., clean and free

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Fig. 33.—Dipping Casements at Braintree. Note the Narrow Tank used for this Class of Work.

from dandruff should be attended to. The doors are best if double, and thick felt may be used with advantage in the joints so as to practically seal the opening when the doors are closed. Air which is admitted, either through ventilators or windows, should be strained before entering the building, and for this purpose silk gauze of the finest mesh is usually employed. In some cases, cotton wool in addition is placed in such a position that the air must pass through it before entering the room. If these precautions are taken it will be found that the quality of the work is greatly enhanced.

It may be observed in this connection that it is important also to provide means of adequate ventilation of the apartment. Moisture charged air has a bad effect upon paint work. Extreme heat is unnecessary, but it is very important that the temperature be maintained at a uniform rate, say 60° F. If the room in which the painting is done is very hot, the paint will be affected and be likely to become too thin for its purpose; while, on the other hand, if the room or articles to be painted are very cold, the paint or enamel will have a tendency to congeal. Both of these defects can be remedied, as already stated, by a good system of ventilation and maintaining the heat, night and day, at a uniform temperature.

A Model Drying Room.

The immense importance of providing a uniform temperature and ensuring an adequate system of ventilation in the room in which goods are placed for air drying can hardly be exaggerated. Unless such a system is in use the actual drying may be greatly retarded and the work stand a chance of being spoiled.

In connection with some of the plant inspected by the author it must be admitted that the provision made in this respect falls far short of what is needed. In one case the work of rubbing down was proceeding in the same shop, although in a different part, in which various goods which had been dipped were hanging up to dry. It need hardly be said that under such conditions it was impossible to keep the work free from specks.

In other cases the drying rooms were inadequate because of the inefficiency of doors and windows. These, it may be remarked, should always be double so as to maintain the heat uniformly.

Every varnish user knows that a draught of cold air which is allowed to reach a coat of varnish while drying is fatal alike to its appearance and durability. The result is almost certain to be a case of "blooming," which to the uninitiated may be described as a film not unlike the bloom of a freshly coloured plum which comes on the surface of varnish exposed under such conditions. Those unacquainted with varnish vagaries are apt to regard this trouble as being the result of inferior materials used in its manufacture. As a matter of fact it indicates nothing of the kind because, speaking generally, the higher grades of varnishes are the most susceptible.

Without doubt the best and by far the most economical plan to adopt is to have a drying room specially built for the purpose of receiving the articles to be dried. If constructed on scientific principles this will not only give a uniform temperature entirely free from draughts and dust but will considerably expedite the work, thereby allowing of a quicker delivery of goods and effecting a great saving of valuable floor space.

The author inspected such a drying room at the works of Messrs. Pinchin, Johnson, and Co., Ltd., at Silvertown, and a description of it will doubtless prove of interest. It is built of 5-ply wood and is about 16 feet square, sufficiently large to hold two full-sized motor bodies or several dozen perambulators, hand wagons, etc. The actual size may, of course, be varied according to the size of and number of articles to be dried. Air is admitted through two ducts situated close to the floor through fine wire gauze, which is provided with a lifting cover by which the amount of air admitted may be regulated.

Immediately over the two air ducts mentioned is a coil of steam pipes which heats the air to, say, 110° F. This, of course, causes it to rise toward the ceiling, but the angle between the ceiling and wallis rounded off by a cove, so that the current of heated air is directed along the ceiling toward the centre of the room where there is another cove and beneath it a coil of cold air pipes which lowers the temperature somewhat. Thus is created a constant motion of the air which may be regarded as the essence of the system.

But there is another very important provision in the shape of an automatic control. This cuts off the steam when any desired heat is attained so that when the drying room is filled up at night before the works close it can safely be left until the morning when the drop in temperature

will not be more than 2 degrees. The steam may be admitted at, say, 10 lbs. pressure, but as soon as the room is heated from 2 to 2½ lbs. will be found to be sufficient. The actual time for heating the room to 120° F. is from 15 to 20 minutes.

The speed with which work is turned out by this well-considered adjunct may be gauged from the fact that a panel may receive one coat of enamel and two coats of flatting varnish in one day, or four coats of japan in the same period.

In addition to the advantages mentioned is the most important one that the drying room renders the manufacturer who is fortunate enough to possess one quite independent of the weather. In the words of the inventors and patentees, "one enabled by its use to create one's own climate."

Fig. 34.—DESIGN FOR SHOW CARD DONE BY SPRAYING.

CHAPTER IV.

Paints for Dipping.

It need hardly be said that the paint employed for this purpose must be of a special character. There are several firms of manufacturers who make a speciality of this class of paints and supply them either ready for use or in paste form, requiring only the addition of white spirit or other suitable thinner to bring them to the right consistency. The following may be considered as the necessary qualities of a paint suitable for this purpose :—

1. It must dry hard in not less than six hours.

2. The pigment must be of such a specific gravity that when mixed with a suitable vehicle or thinner to form a paint the pigment will not quickly deposit at the bottom of the tank or settle out.

3. The consistency of the paint must be so arranged that only a minimum quantity will run off, while it must not be so thick as to give rise to tears or runs.

White lead which has a specific gravity of about 6.750 is for the reason mentioned usually considered too heavy, and in the case of a white or grey paint, zinc oxide which has a specific gravity of 5.470 is used in preference. The following colours may also be successfully employed, because of their low specific gravity, viz., Oxford ochre (s. g. 2.822), Venetian red (s. g. 3.560), Indian red (4.732), golden ochre (3.107), Italian raw sienna (3.081), burnt sienna (3.477), Turkey umber (3.496), Prussian blue (1.956), bone black (2.319).

It will be observed that the earth colours, such as ochre, sienna, umber, etc., are all light pigments, and as they are also recognised as being the most durable, they are eminently well suited for use in many positions, although the colour is not always very agreeable. Precipitated barytes (s. g. 4.144) can be used up to, say, a proportion of 10 per cent. —not more; red lead (s.g. 8.681) cannot be used for this purpose, as it is far too heavy, and the same applies to English

vermilion (s. g. 7.726). If, however, a bright colour is required, it may be obtained by dipping in Venetian red or Indian red and giving a second coat of crimson lake (s. g. 1.898), but a coat of varnish should be sprayed upon this for protective purposes.

In considering this subject, it is well to remember that much will depend upon the thickness of the vehicle used, as, clearly, a fairly heavy pigment will settle out in a thin vehicle much quicker than it would in a comparatively thick one. The successful paint, therefore, is one in which both considerations are taken into account.

Very rarely indeed does it pay manufacturers to attempt to grind or prepare paints themselves, and much greater satisfaction will be obtained by getting supplies from a reputable firm who have made a special study of the subject.

Sometimes a white paint is required for dipping, and in that case 30 lbs. of sublimed white lead, 10 lbs. of zinc oxide and 6 lbs. of gilders' whiting, with 4 lbs. of asbestine pulp, mixed with 9 lbs. of raw linseed oil, will be found to give good results.

A paint which dries with a gloss is often desired for the finish of many articles, and can be readily obtained by first priming, then giving a finishing coat of paint on it which has been mixed with sufficient varnish to produce the desired gloss. In some cases three coats may be given, namely, the first or priming coat, the second, which should be flat, or semi-flat, and the third a coat of varnish paint, which will dry with a gloss. It should be pointed out, however, that the finish obtained by these means is not a little inferior to that which may be produced by using over the priming one or more coats of flat paint of the desired colour and finishing with a coat of suitable varnish, which may be applied either by dipping or spraying, according to circumstances. A point here worthy of mention is one which every house painter is or should be well acquainted with, and that is that the coats of paint that are superimposed should be alternatively flat, *i.e.*, without gloss, and glossy, in order that each may adhere closely to the other. If the article to be painted is wood or any other material which is of an absorbent character, a comparatively large amount of turpentine and oil must be mixed with it in order to allow for suction. This will dry with a semi-flat finish, and a glossy coat or one having more oil in its composition, may be applied over it. If a further coat is required it should be flat or nearly so, and in that case a finishing coat of

varnish will probably be required. The paints for these purposes may be purchased ready made or ready for thinning down, from firms who have made a special study of the requirements.

The question sometimes arises as to whether paint dipping or spraying can be used advantageously when in the finish two or more colours are to be used. As a rule the difficulties can be overcome by dipping first or even the second coat, spraying on the third or finishing coat, using specially prepared masks or shields over those parts which are not to be painted with the particular colour in use.

The following useful information is taken from "White Paints and Painting Materials," by W: G. Scott, who was for sixteen years connected as paint expert with the Milwaukee Harvester Company and the J. I. Case Threshing Machinery Co. Mr. Scott therefore speaks from a wide experience. He says :—

A certain amount of oil must be present in dipping paints to act as a binder, and it is advisable to add a small quantity of varnish to hold the paint together. The desired features in a good dipping paint are: freedom of flow and proper drip ; sufficient binder to prevent chalkiness and produce a firm coat ; covering capacity and an even distribution of the paint.

Non-absorbent surfaces like metal and hard wood require less oil than the absorbent soft woods.

In the former case there is little or no penetration of the liquid portion of the paint, but with pine, bass wood, white wood, poplar, etc., nearly all of the liquid is absorbed or taken up by the wood, consequently with benzine only as a thinner there will not be sufficient binder present to hold the pigment when the thinner evaporates.

Whereas 5 lbs. of paste pigment or colour ground in oil and thinned with a gallon of benzine would produce a suitable primer on iron or other non-absorbent material, it would not answer for soft wood.

Dipping paints, as a rule, contain from 4 to 10 lbs. of paste per gallon of thinner, the primer containing less paste than the second coat paints.

The composition of the paste colour has much to do with the dipping paint; for instance, 5 lbs. of paste white lead to the gallon of thinner will cover and work better than a mixture consisting of half white lead and the other half made up of transparent pigments like china clay, barytes,

etc., nevertheless a small amount of inert material is generally understood to be an improvement in the way of durability.

Asbestine, whiting, silica and china clay are the inert materials most often used in paste goods for dipping purposes.

Asbestine probably helps to hold the pigments in suspension better than any of the others and answers nicely for dipping paints, but, as previously mentioned, does not allow the paint to level out when used with a brush.

China clay, on account of its low specific gravity, is much favoured as a suspension agent, but materially lessens the opacity of the paint.

A small amount of whiting is a good addition to a dipping paint, as it carries down much of the dirt and heavy particles usually produced during the process of dipping. Silica gives the paint "tooth," and by some authorities is considered an actual necessity in primers which are intended to be sand-papered.

White lead and zinc oxide are the two ideal white pigments considered from a dipping standpoint, and it will be found that the majority of dipping paste paints on the market contain a notable quantity of zinc oxide, either straight or in the form of zinc lead.

Zinc oxide is generally the predominating pigment in the white and tinted paste paints, and is usually associated with white lead (basic carbonate), zinc lead, and sublimed white lead, mixed with more or less inert material according to the ideas of the manufacturer or in order to cheapen the product.

The admixture of inert material with the coloured pigments requires some knowledge of the composition of the coloured pigment; for instance, lampblack might be safely mixed with asbestine, whiting, silica, barytes, etc., without detriment, but yellow ochre containing, naturally, considerable clay and silica would hardly permit of any great addition of china clay or silica.

The strong iron oxides, chrome greens and similar tinting colours will stand a large quantity of inert material when the paint is to be used as a body colour, but for varnish colours it is customary to use the chemically pure colours and less paste per gallon of thinner.

Paste paint for varnish colours is frequently ground in oil, in japan, or in a mixture of the two, but far better results are obtained by grinding the dry pigment in varnish thinned to a grinding consistency with a little turpentine.

A varnish with a viscosity of 20 (water = 1) which gives a stiff mix with, say, 5 lbs. of pigment will, when thinned to a viscosity of that of raw oil, *i.e.*, a viscosity of 4, take about 20 lbs. of pigment.

No set rule can be given for the kind and amount of thinners to be used in dipping paints for various purposes, but the following proportions* will furnish a key to the general mixtures used :—

PRIMERS FOR METAL.

4 to 5 lbs. of paste thinned with $\frac{7}{8}$ to 31/32 gallon of benzine or turpentine and $\frac{1}{8}$ to 1/32 gallon of mixing varnish.

PRIMERS FOR HARD WOOD.

4 to 5 lbs. of paste thinned with 15/16 gallon benzine or turpentine, 3/64 gallon raw oil, 1/64 gallon mixing varnish.

PRIMERS FOR SOFT WOOD.

4 to 7 lbs. paste thinned with $\frac{1}{2}$ to $\frac{3}{4}$ gallon benzine or turpentine, 15/32 to 15/64 gallon raw oil, 1/32 to 1/64 gallon varnish.

In some cases, with very soft, porous woods, it may be necessary to add more raw oil and some japan or liquid drier, but too much drier must not be added, as it will shorten the "flow."

SECOND COAT DIPPING PAINTS.

5 to 10 lbs. of paste thinned entirely with benzine or turpentine, or with $\frac{7}{8}$ gallon of solvent and variable proportions of oil and varnish according to the surface desired.

Varnish is advocated in all of these mixtures, as it helps to hold the solids and liquids together and prevent separation ; it also induces toughness.

It is essential that a varnish be used which will mix perfectly with oil and benzine at a temperature of 60° F.

Varnish colours are best thinned with turpentine, but owing to the high price of turpentine the large factories insist on using benzine or some of the turpentine substitutes now on the market.

The fact that some of the turpentine substitutes work better and give a better "flow" with the paint and varnish,

* The figures given relate to an American gallon, which contains 231 cubic inches, while an English imperial gallon contains 277$\frac{1}{4}$ cubic inches. For practical purposes the latter may be considered one-fifth greater than the former.

is due to the fact that most of them contain a heavy distillate of petroleum similar to kerosene.

Kerosene oil has the double property of thinning and imparting "flow" to either paint or varnish, but retards the drying, hence too much must not be used.

Damar varnish, which will not stand thinning with benzine without separation of the gum or becoming cloudy, will permit of dilution with kerosene to quite an extent.

So far as durability is concerned, kerosene imparts more durability and is more waterproof than any of the other thinners. Combined with rosin and manganese oxide, it may be made to dry like raw linseed oil, but, of course, does not possess the same properties.

In dipping paints, as in all other kinds of paints, good judgment must be used in the mixing, and it is absolutely essential that paints for soft wood, or other absorbent material, contain enough oil, or binder, to hold the pigment.

WHITE PASTE PRIMER. EXTRA FINE.

300 lbs. white lead (carbonate).
150 ,, zinc oxide.
50 ,, floated silica.
Grind in
10 gal. raw linseed oil.
Product = 575 lbs.

This paste is thinned with turpentine or benzine for dipping purposes in the following manner :—

WHITE DIP FOR METAL.

100 lbs. of white paste.
14 gal. turpentine or benzine.
½ ,, pale mixing varnish.
¼ ,, white liquid drier.

WHITE DIP FOR HARD WOOD.

100 lbs. white paste.
13 gal. turpentine or benzine.
2 ,, raw linseed oil.
¼ ,, pale mixing varnish.
½ ,, white liquid drier.

WHITE DIP FOR SOFT WOOD.

100 lbs. white paste.
12 gal. turpentine or benzine.
6 ,, raw linseed oil.
¾ ,, white liquid drier.

The pale mixing varnish and the white liquid drier must not liver with lead or zinc, otherwise, the paint in the tank will thicken continually.

The above formula produces one of the best paints known, and it is certainly not a cheap paint.

White Spirit.

As already mentioned, many firms who use the paint dipping process buy their paint in paste form with the requisite amount of driers added, and thin it themselves with white spirit, which is a petroleum product specially prepared for the purpose. Turpentine is, of course, too expensive, and the spirit costs, under normal conditions, little more than one-third of the price, although exact figures cannot be given owing to the fluctuation in the price of these materials. Some manufacturers use a white spirit, to which has been added from 25 to 30 per cent. of genuine American turpentine. This, of course, renders the mixture somewhat expensive, and possesses no advantage excepting that it gives the characteristic smell of turpentine; but this, it appears, is not important in a factory, and the pure white spirit is quite suitable in itself.

According to Mr. S. Roy Illingworth, A.R.C.Sc., A.I.C., B.Sc., Lond., expert to the Gas Lighting and Improvement Co., Ltd., turpentine substitutes were first placed on the market about 30 years ago, and consisted at that time of a mixture of turpentine and kerosene oil. Investigations led to the production of white spirit, drying as quickly as turpentine, or even quicker if desired. Several grades of this material are made, varying in flash-point from 80° up to 150°. The flash-point of genuine turpentine, it may be mentioned in passing, is 90° to 91°, and the 90° flash-point spirit is the one usually employed for painting purposes, although the 80° flash-point would answer equally well for dipping. The best grade is practically free from smell and is suitable for admixture in all paints, excepting those having a bitumastic or asphaltic base, or paints in which very common driers containing cheap rosin are used. A rough-and-ready test as to the quality of white spirit is to dip a piece of blotting-paper into it and hang it up to dry. In the course of an hour-and-a-half it should have wholly disappeared, leaving no smell or stain behind it. If there should be a stain the sample should be viewed with suspicion. Another test of the same kind is to drop a little spirit on a piece of white writing paper and to leave it for

three-quarters of an hour, when it should have disappeared without leaving a stain. In addition to these tests it might be advisable to mix a little spirit with paint and to try it experimentally.

In the evaporation of turpentine it is usually admitted that a small proportion, say, from ·25 to ·50, is left behind owing to oxidation. In the case of best white spirit, however, very little residue will be left behind, certainly not sufficient quantity to interfere in any way with the drying. The use of the spirit has proved so successful that practically nothing else is now employed in paint dipping. It is, however, important, of course, that the best quality white spirit be used, but as this is so much less in cost than turpentine, there is no temptation to use an inferior quality.

The Quantity of Paint Required for Dipping and Spraying.

Speaking generally, rather less paint will be required when it is applied by dipping, or spraying, than is necessary when it is applied with a brush. But there are many exceptions, particularly in spraying, where it may be necessary to give a coat considerably thicker than usual.

The following table will be found useful as a guide, but it should be remembered that the actual space covered will vary considerably with different grades of paint, so that the table should only be taken as approximately correct. In cases of doubt, careful calculations should be made after a given quantity of paint, varnish, or lacquer has been applied to a surface of known area. This will serve as a useful guide in ordering in the future. It need hardly be said that the quantity of paint necessary will vary largely with the surface to which the paint is applied. For example, an absorbent surface, such as unprimed wood, will require much more paint than metal work, which absorbs little or none.

Spreading Capacity of Paints.

	Per Gallon. on Wood.	Per Gallon on Metal.
Priming Coats	60 to 70	90 to 100
Mixed Paint 2nd coat	85 to 90	100 to 120
Varnish (on paint)	95 to 110	120 to 130
Lacquer (on paint)	100 to 115	130 to 150
Enamel (on paint)	75 to 80	85 to 95

CHAPTER V.

PAINTING BY COMPRESSED AIR.

The Evolution of the Apparatus Employed.

By way of introduction to the subject of the application of paints, enamels, lacquers, varnishes, stains, etc., by means of compressed air, a few notes on the development of the method may be given, if only with the object of correcting the impression, which sometimes exists, that such apparatus as is now employed is more or less of an experimental character.

The early attempts to apply paint, etc., to articles other than by the old method of brushing were mainly carried out with a type of machine still largely used for whitewashing, and the principle adopted was to partly fill a convenient tank with the paint or whitewash and to pump a pressure of 35 to 40 lbs. into the tank by means of a suitable hand pump. The paint was forced through a flexible tube attached to a connection near the bottom of the tank, and at the other end of the tube was a simple form of nozzle with a trigger control for the paint.

It may be said at once that this method was doomed to failure owing to the underlying principle being at fault. While eminently suitable for applying whitewash or distemper, it was hopeless for paint of a more viscous character, owing to the fact that the latter was not atomised as it issued from the nozzle.

The type of machines referred to, viz., those which are used for spraying lime white, distemper, whitewash, etc., are fully described and illustrated in another chapter.

After failing to achieve satisfactory results with such simple apparatus when applying viscous paints, etc., further experiments were carried out with a somewhat different type, commonly known as the "kettle" type of sprayer. The principle employed was to employ compressed air, supplied, in this case, not from a hand pump

but some form of power compressor, and at a pressure varying from 20 to 50 lbs. per square inch.

The air was delivered through a nozzle controlled by a convenient plunger or trigger type of valve, and impinged at an angle across a similar nozzle communicating with the paint receptacle of the sprayer. The action of the air impinging on or across the paint nozzle created a vacuum in the paint tube, and thereby sucked up the paint from the receptacle and gave a fan-shaped spray. Up to a point these experiments proved satisfactory, but still did not overcome the difficulty of successfully dealing with intricate shapes, small articles, and particularly in applying heavy paints with fair percentages of varnish embodied therein.

The Concentric Form of Spray.

Attention was therefore directed to the concentric jet form of sprayer, and this is now almost universally employed where painting, enamelling, etc., is carried out on a large scale.

The advantages of the latter type are many, and in addition to being designed, in most cases, to produce the greatest effect with the least possible consumption of air, they are also capable of applying the paint in very finely divided particles to the smallest work, such as buttons, imitation jewellery, small electrical camera parts, or of applying silky coats to such large work as motor bodies, constructional iron work, large tinplate work, agricultural machinery, domestic gas apparatus, etc. at a speed approximating to four to ten times the speed of handwork, and giving a far superior finish, in many cases with less coats.

Many people who contemplate the subject of painting with a spray think only of a smother of paint being discharged from a nozzle. They are not aware that the colour can be better controlled in a suitably constructed spray than is possible with a hog's hair brush.

The flow of paint is stopped or started instantly, and the amount of paint delivered is at all times under perfect control, so that a quantity corresponding to that delivered by a ¼-inch brush or pencil can be increased to the quantity distributed by a 4-inch brush in a single stroke. In other words, you have a tool which is the equivalent of half a dozen brushes ranging from ¼ inch to 4 inch in width.

A little practice is, of course, necessary to master the instrument, but nothing like the practice which is required for successful painting with hog's hair.

The principal care is to put on the paint until the beads of paint coalesce. Too much would make the paint run, too little would not leave the surface covered. When properly done the surface is superior to other painting, as the hairs of the brush are not dragged through it to disturb the evenness of the surface.

The air pressure required for painting varies with the consistency of the paint, its viscosity as well as its thickness. Some liquids have a quality of stringiness or hanging together which require a higher pressure to break up.

Thin lacquers and varnishes may be sprayed with 18 or 20 lbs. to the square inch, and from that to about 50 lbs. will cover most classes of paint.

The lowest pressure at which a paint breaks up is the best pressure to use, as high pressures have a tendency to make more dust and put fine particles of paint in the air, where they are not wanted.

The volume of air has also to be considered. This varies with the size of the aperture through which it exhausts and to some extent with the pressure—for a small nozzle such as is used for lacquers and thin liquids, say, one cubic foot of free air per minute, and up to 3 cubic feet for oil paints.

When it is stated that a pistol sprayer consumes say two cubic ft. of free air per minute, it means when working almost continuously, but as the periods of actual work do not represent more than two-thirds of the actual number of working hours, there is a margin left. Nevertheless, it would be unsafe to state a lower figure, for in some cases where convenient feeding of the work to the operator is arranged, the consumption of air is continuous.

It should also be remembered that the air is used for other purposes, i.e., a small amount is used to provide a pressure feed of colour to the instrument in many cases, and where a heater is employed, a small amount of air is by-passed through the pistol to keep this warm when spraying is momentarily stopped. Although the practice of heating the air slightly increases the ultimate efficiency of a given compressor, yet it is unwise to count too much upon this fact.

In submitting the following figures as to air consumption, the Airostyle pistol has been taken as a type:—

For work with a tip and needle of 1 m/m. dia., 1 cub. ft. per minute; 1½ m/m. dia., 1¾ cub. ft.; 2 m/m. dia., 2½ cub. ft.; 2½ m/m. dia., 3 cub. ft.; 2½-3 m/m. dia., 3½-4 cub. ft.; 4½ m/m. dia., 5 cub. ft.

These consumptions naturally vary slightly with the adjustment of the nozzle of the pistol, but they are from actual tests and so may be taken as authoritative.

CHAPTER VI.

Types of Spraying Apparatus.

We now come to a consideration of the different appliances by means of which the actual spraying is effected, and in order to avoid any suspicion of partiality the review of instruments, etc., in use will be dealt with alphabetically.

The Aerograph.

First, therefore, comes the Aerograph Co.'s Spray Painter. This instrument is of the concentric jet type, and was one

Fig. 35.—The Aerograph Spraying Instrument.

of the first of the kind made in Europe. It is capable of excellent work. In Fig. 35 is shown one form of the handpiece. A flexible tube for compressed air connects with the nipple A. The finger lever F controls both the air valve and a colour valve in the nozzle N, so that little or much colour

may be allowed to pass out into the current of escaping air.

The colour may be supplied under pressure, through a flexible tube from a large paint pot, and pass through the tube P to the nozzle N, or in smaller quantities from a cup C, which is attachable at B, and when so attached cuts off the supply through the tube P. This cup is useful when small quantities of colour are wanted with frequent changes. A ball joint permits work to be done in either an upward or downward direction.

Fig. 36.—Form of Aerograph Suitable for Spraying Vertically or at an Angle.

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Fig 37.—THE AEROGRAPH ELECTRIC MOTOR OUTFIT.

Fig. 38.—PAINTING A GASOMETER.

In Fig. 36 is illustrated a pistol pattern of the Aerograph, which has a large side cup which can be sprayed at any angle, being adjusted to facilitate spraying in an upward, downward or horizontal position. Thus work can be done by it on table, wall or ceiling. The cup referred to contains the paint or other liquid to be sprayed, and a series of cups may be provided for a quick change of colour, if desired, as will be readily understood.

In cases where electric power is available, the electric motor outfit shown in Fig. 37 will be found very serviceable. It may be described as a "spray painter" outfit complete, and it includes a 1 h.p. motor mounted on a trolley ready for use, which can be employed for many different classes of work. In Fig. 38 it is shown being used for spraying paint on a gas holder. It would appear that this outfit might be employed for ship bottom painting, provided that the necessary scaffolding or its equivalent were available.

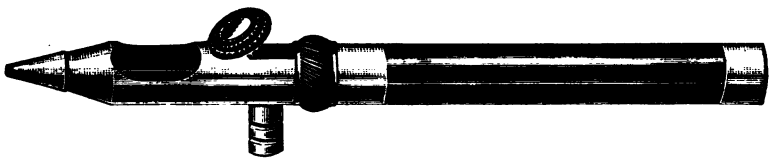

Fig. 39.—SMALL AEROGRAPH FOR DELICATE WORK, LINING, LETTERING, ETC.

Going to the other extreme, a form of Aerograph, suitable for very delicate work, is shown in Fig. 39. This may be used for photograph retouching, pottery, and small decorative work generally—in fact, it is suitable for any work requiring delicacy of work.

In another chapter the subject of artistic work done by means of compressed air is considered at some length, and a number of specimens of work executed by this process are given.

THE AERON.

The system of spraying is manufactured by the De Vilbiss Manufacturing Co., Toledo, Ohio, U.S.A., and 71, Newman Street, London, W.

The method consists, briefly, in spraying stain, shellac, varnish, or enamel, as the case may be, on the work by the means of compressed air, under a pressure varying from 30 to 80 pounds per square inch.

The necessary outfit comprises the Aeron sprayer itself —which is made in two styles and several sizes—the air

compressor and receiver, an air transformer set, for regulating the pressure and purifying the air supply, a steel Fumexer, in which the work is done, and an exhaust fan to disperse the vapours or fumes resulting from the atomising of the finishing material. Besides these necessary appliances, turn-tables are used where advisable to facilitate the handling of the work while the "aeroning" is being done.

The two styles of Aerons are shown in the illustrations, each connected with an air transformer set to which the air supply pipe is attached. In one style of Aeron the finishing material is carried in a pint or quart capacity cup forming a part of the Aeron itself. The other machine takes its supply from a five-gallon container suspended above the nozzle. The work is placed in the Fumexer on the turn-table, which can be tilted at any convenient angle and revolved by hand, and is coated on the top, sides, and front, with the drawers in place. Drawers may also be finished inside by this process.

A full coat can be applied to a vertical surface as well as to one in a horizontal position. There are two reasons why. It is impossible to put on a perfectly uniform coat with a brush, especially on a vertical surface, and runs and sags are caused by the heavier portions of the coat dropping down over the lighter coated spots. With the Aeron a uniform coat of varnish is applied, and it is a fact that as the coat is the same over the entire surface it will not run, even if it is as heavy as a brush coat, which would show sags. The second reason is that an Aeron coat sets somewhat quicker than a brush coat, owing to a slight evaporation of the solvent caused by the action of the compressed air. Again, since the coat is uniform it sets uniformly. For the same reason the final drying is hastened to some degree.

In brushing flat horizontal surfaces where a heavy coat is applied it is almost impossible to avoid fatty edges, and in brushing carved or ornamental relief work the low spots are sure to collect more varnish than the high places. Corners and edges in panel work are also causes of difficulty in this respect. In using the Aeron the surface varnished is covered uniformly and evenly, whether flat, panelled or carved, with one sweep of the machine at an even speed. Consequently, heavy spots, runs and fatty edges are entirely avoided.

In applying finishes with the Aeron a slight reduction of the material with turpentine or other solvents is logical;

with some materials, necessary. Reducing is logical on account of the slight evaporation of solvent previously mentioned. In other words, in order to have the Aeron application of the same consistency after reaching the surface as it is when brushed, a reduction of from 5 to 10 per cent. would be required. This is not always desirable by any means, especially in the case of the heavy gloss coat spoken of. Whenever a free-flowing coach varnish is used, reducing is not necessary. Conditions in different plants govern this matter to a great extent.

Rubbing varnishes are usually reduced slightly, as a full-bodied, heavy coat is not required, also because a rubbing varnish does not flow as readily as a coach varnish. On account of this evenness of the coat, an Aeron coat of rubbing varnish is somewhat more easily and quickly rubbed either by hand or by machine.

Undercoat varnishes are reduced to some extent for Aeron work for similar reasons. They are also more easily sanded than when brushed.

Pigments, primers or first coaters are Aeroned to better advantage if the pigment content is less than for brushing. It is also sometimes desirable and expedient to use a more finely ground pigment.

Flat finishes are applied to great advantage, and, because of greater uniformity of surface, more closely resemble a rubbed finish than when brushed.

This spray offers perhaps greater advantages in the application of shellacs than with other materials. It is a matter of common knowledge that shellac is very difficult to brush, while, on the other hand, it sprays easily. Instead of cutting the gum 4 or 5 pounds to the gallon of alcohol, as for brushing, the material is used in the proportion of 2½ to 3 pounds of gum to the gallon. The sprayed coat of shellac is perfectly smooth and uniform, and requires practically no sanding compared with the work necessary to sand a brushed coat.

The Aeron is simple and easy to operate, and a week's work is sufficient to make an efficient and expert operator of the average man.

The work is clean, and, what is more, is healthful and sanitary, as all vapours and fumes are removed from the finishing room by the exhaust fan used with each outfit.

Cleaning the Aeron is accomplished by spraying a solvent through the nozzle instead of the finishing material, and the whole machine may be placed in a can of thinner

overnight if desired. It is necessary to clean the Aeron but once a day if it is used more or less continuously. The whole operation of cleaning may be performed in a minute or two.

There is usually some loss in finishing material when the Aeron is used, though this is hardly noticeable except on small work, when it may amount to 15 or 20 per cent. In many cases there is no waste, in others an actual saving —where coats are eliminated by the use of the machine. On an average, however, there is some slight loss—largely of the solvent used in reducing the material. In any event, however, the waste is offset many times by the saving effected in time and labour, without taking into consideration the saving in floor space, the greater ease in handling the work, the better quality of the work done, the advantage to the workmen, and, finally, the general all-round convenience of the Aeron system.

Description of the Illustrations.

We will now give a description of the illustrations of the different parts of the Aeron. Fig. 40 shows the attached cup straight barrel Aeron, which can be fitted with either metal or glass cups. Metal cup is the standard equipment.

Attached cup Aerons can be furnished with four sizes of nozzles: F—.047″ dia., E—.070″ dia., D—.081″ dia., and C—.094″ dia. These nozzles are selected according to the nature of the work that is to be done.

Fig. 41 shows an attached cup angle barrel Aeron, a type of advantage in spraying work lying in a horizontal position.

In some classes of work, where the liquid to be sprayed is apt to settle, an agitator is required, such as is shown in Fig. 42.

In Fig. 43 is shown an attached cup Aeron with type V double nozzle spray head. This type is especially adapted for the finishing of large surfaces, such as automobile bodies, case furniture, etc.

The V spray head shown separately in the above illustration is interchangeable with the single nozzle spray head, and can be attached to any standard Aeron.

Type G Aeron is illustrated in Fig. 44. The nozzle is ·027 inch in diameter. This Aeron can also be furnished with other sizes of nozzles to special order.

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Fig. 40.

Fig. 41.

Fig. 42.

Fig. 43.

Fig. 44.

THE AERON SPRAYER.

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Fig. 45.

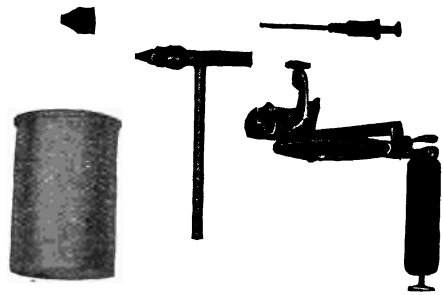

Fig. 46

Fig 47.

THE AERON SPRAYER.

In Fig. 45 are shown various attachments used with this form of sprayer. At the top left-hand corner is a cup-holder and screws, and on the right, metal or glass cups. Beneath are cleaning pail and length of pressure tubing with connections.

Fig. 46 shows the construction of the Aeron, the parts being disassembled for ease of cleaning.

We now come to the type of Aerons which take their supply of material from a five-gallon tank placed above the level of the nozzle, the fluid flowing down by gravity. This arrangement offers all the advantages of the pressure feed tank type with none of its disadvantages. It is shown in Figs. 47 and 48.

The next type is termed the M Aeron with V—A spray head and is illustrated in Fig. 47.

There is the same advantage in the use of this Aeron as with the former type in that the supply of material is taken from a container placed overhead, the fluid flowing down by gravity. The slightest pull upon the trigger releases the material instantly—the varying of the pressure adjusts the flow automatically. As with the type L there is but one adjustment.

This type Aeron is built for large work. It produces a "wide spray," similar to the V spray head, which covers large surfaces with remarkable rapidity.

The nozzle can be turned so that a full, fan-like spray is projected horizontally, vertically, or in any intermediate position.

A container with agitator and hose for types L and M Aerons is shown in Fig. 50.

It is drawn from one sheet of steel and is heavily tinned to prevent rust.

The standard and block and tackle (Fig. 49) are furnished for holding the container above the level of the Aeron. The block and tackle, which is of the safety, self-locking type, is recommended where it is possible to obtain a ceiling fastening. The standard (Fig. 51) can be used if the block and tackle is impracticable.

The air transformer set (Fig. 52) is for the purpose of regulating and purifying the compressed air, and is a necessity with each Aeron installed. The air duster (D) is a valuable addition to the equipment for removing loose dust or dirt from the work before finishing.

The auto-filter (S) is for removing dust, grit, and oil from the compressed air. The auto-regulator and gauge (R)

makes possible the regulating of the air pressure between 5 and 80 pounds, simply by turning a thumb-screw. The auto-condenser (C) is for separating moisture from the compressed air.

Full details of the air compressor and other special appliances used in connection with the Aeron will be found elsewhere.

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Fig. 48.

Fig. 49.

Fig. 50.

Fig. 51.

Fig. 52.

THE AIROSTYLE.

Next comes the Airostyle and Lithos, Ltd., with their "Airostyle" type Record, also a concentric jet-type, an illustration of which is given in Fig. 55 and a section of which we give also in Fig. 54. This type is largely used for small, medium or large work, and is considered to be extremely sensitive and very fast in operation. It has a gunmetal casting for the main body, and all wearing parts are of steel, tempered or case hardened.

It is supplied either with or without pressure fed accessories, although the makers are strong advocates of pressure feeds for most work, and with which they have met considerable success.

In addition to the Record Pistol this firm makes other types, and in order must be mentioned the type "Ultra" for use where frequent changes of colour may be necessary, and where no continuous colour feed is required. This type is specially adapted for stencilling in oil colours, and is illustrated in Fig. 56.

Another type about to be introduced is shown in Fig. 53, for small and medium work, simplicity of construction and ease of adjustment being specially claimed for this type. This type is called the Airostyle Pistol "M."

Yet other type of Airostyle may be mentioned for smaller work, namely, the "Stencil and Universal Lustre and Photo," which is illustrated in Fig. 53.

These types are mainly employed for decorative work, and give a very wide selection, but save that they are employed in process work and for textile goods, they do not enter into the scope of this book.

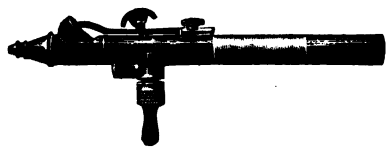

Fig. 53.—AIROSTYLE TYPE PHOTO.

As the pistol type is used for all general painting and japanning, the adjustment of this may be advantageously explained in greater detail, and referring to Fig. 54 the instructions are as follows:—

If a wide spray is required the nozzle 8 is unscrewed

to a small extent and then locked by means of a small ring 8a, but if a narrow spray is wished for, the nozzle 8 is screwed on farther and locked in position. On all-round work one position serves, that is, a position in which the recessed point of the nozzle coincides with the end of the tip 9, which just allows the needle 5 to project through it. If it should happen that a leakage of colour

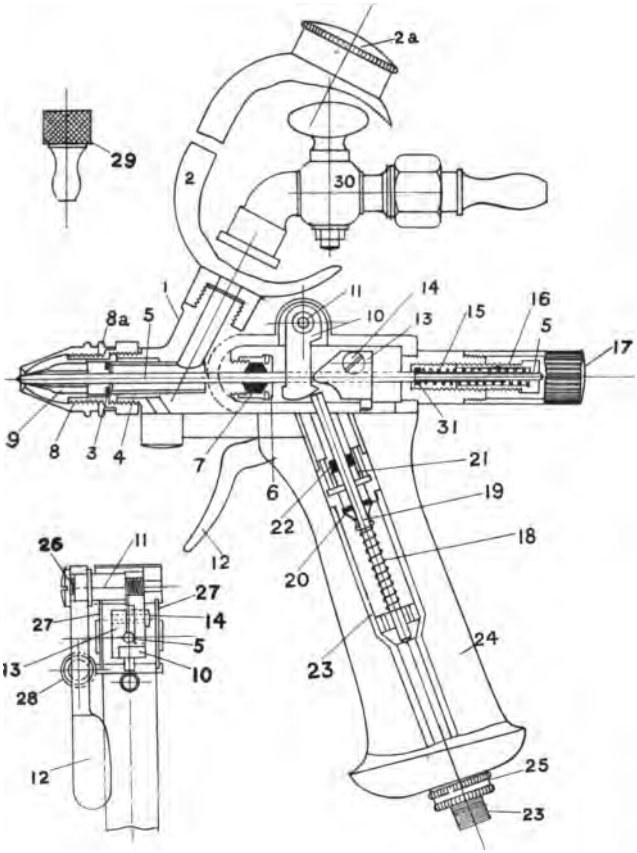

Fig. 54.—Section Showing Construction of the Airostyle.

occurs through 9 when spraying is suspended, this may be obviated by giving an increased tension to spring 15 which may be obtained by screwing in the spring box 16 slightly. It may happen that some foreign matter becomes lodged in 9, in which case the pistol from

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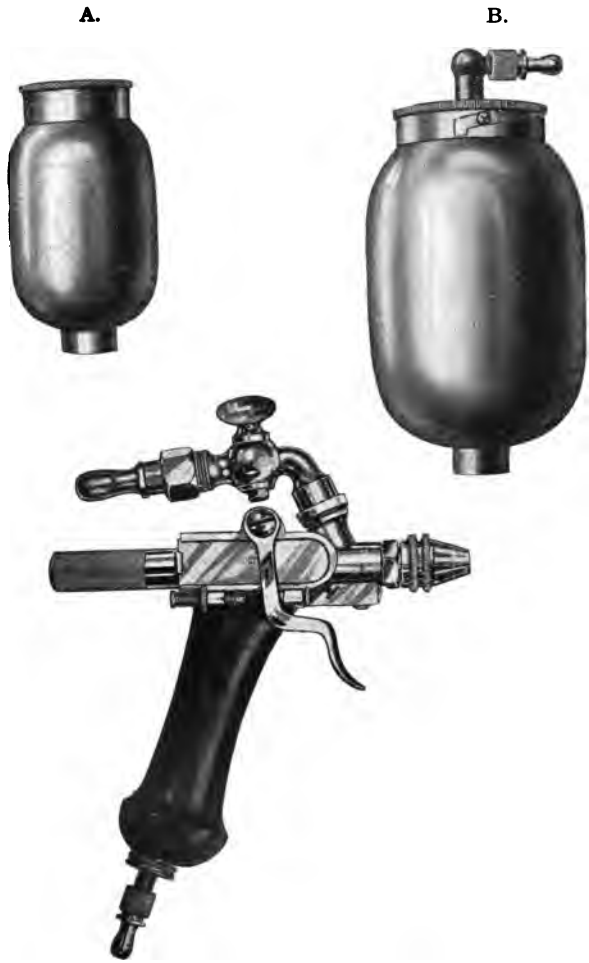

Fig. 55.—Airostyle Type "Record" with Union for Continuous Supply.

A—Small Pressure Bowl.

B.—Small Simple Bowl.

he colour tube must be first disconnected, the nose 4 removed and the parts brushed or swilled with turps or spirit. This having been effected, the nose 4 will be replaced, care being taken that the washer 3 beds down on its seating in the body of the pistol.

It is well to provide for any possible contingencies which may arise, and it may, therefore, be remarked that if any leakage of air occurs through the air valve 19, it will probably be caused by some grit to be found on the face of air valve washer 20, and to remove this the handle can be taken off by unscrewing the milled nut 25 and the valve

Fig. 56.—AIROSTYLE TYPE "ULTRA."

body 23 in order to get to the air valve. The replacement of the parts is simple.

The adjustment of the pistol for working is made as follows :—First release the screw 14 on cross head 13, and while the instrument is connected up with the air supply, slightly withdraw the trigger 12, allowing a small amount of air to pass through the nozzle. While maintaining the trigger in this position, move the cross head along the needle until it just bears against the cam 10, and in this position clamp the same by screwing home the clamping screw 14.

Fig. 57.—The Airostyle Pistol "M."

Another important point is to see that the lubrication of the compressor is carefully watched; the sight feed lubricator on top holds sufficient lubricant for 10 working days and is capable of adjustment by means of a needle valve. It can, therefore, be easily set. The main bearings are ring oiling and only need occasional attention. The fan bearings are ball bearings and only need attention once in six months.

The Eureka Spraying Machine.

An inspection of Figs. 58 and 59 will show that this machine is of entirely different construction to those already described. The advantages claimed are the simplicity in construction, the absence of complicated parts which might get out of order, and the fact that the machines cannot clog in use. The operation is as follows: The feed pipe from air tank should be connected up with a high-

Fig. 58.—The Crane "Eureka."

pres ure hose to the sprayer and a fluid nozzle is then adjusted so that the tip of the nozzle is in alignment with the centre of the air nozzle. This adjustment varies according

to the thickness of material. When using thin liquids the fluid nozzle should be slightly below the centre of the air nozzle. When ready for spraying valve is pressed, and this releases the air, which blows through the air nozzle, across the top of fluid nozzle and draws up the material from the inside, spraying the fluid on to the work. The shape of the spray is that of a fan. The air pressure required varies from 20 to 50 lbs. according to the viscosity of the material being

Fig. 59.—The Crane "Record."

dealt with. As a rule the best results are obtained when the machine is held from 4 to 6 in. away from the work. The Fredk. Crane Chemical Co., Armoury Close, Bordesley Green, Birmingham, are the agents for these machines, and it is also manufactured in the United States. The remarks given under the head of "Exhaust," "Air Compressor," etc., will apply to this machine also. It may be observed that the cup holding the metal can be very quickly changed, so that a variety of colours may be sprayed one after the other

with very little trouble. The price of the machine (which may be provided with an agitator if required) is low.

"THE INVINCIBLE."

These sprayers are designed on an excellent "universal movement" principle and are particularly well constructed throughout. They further claim distinction on the score that every section is an independent unit of standardized pattern, and as spare parts are always available, replacements and renewals can be made instantly with the minimum of trouble and cost.

They are made in several types to suit varying classes of work, ranging from the fine lining and shading of small objects required by artists, etc., to commercial painting on the scale practised by motor car manufacturers and other large users; and important points in their favour are the special facilities provided for quick cleaning after use, their completely enclosed mechanism, which prevents the penetration of any dirt, colour or liquid to working parts, and the adjustment of the needle so that no pressure or damage can occur at any time to the colour tip, even if trigger is allowed to snap forward.

Automatic control is also provided for work requiring a given volume of colour, it being only necessary to turn a regulator to ensure a constant flow of any desired density.

The "Invincible" Pistol Sprayer type "E" is illustrated in section (Fig. 60). The body is gun metal with working parts of finest steel, highly polished where necessary to ensure smooth working and minimum of wear. The instruments have a handsomely nickelled finish.

WORKING.—When connector (4) is attached to colour cup or extension cock for paint pot and connector (18) affixed to air-line, the air brush is ready to commence work.

DUSTING.—No separate or special dusting attachment is necessary with the "Invincible" apparatus, as a slight pull on trigger (20) carries back steel sleeve (7), depressing steel ball (15) and bringing the air valve (19) into "open" position. This allows a stream of air to pass forward through air channel (21) to nozzle (1) and the projection of this upon surface to be treated removes all dust.

SPRAYING.—A continuation of the trigger pull carries back the spring buffer (8) and opens the control barrel (11)

INVINCIBLE SPRAYER TYPE "E" IN SECTION.

Specially designed for heavy Industrial Work, such as Japanning, Painting, Varnishing, Lacquering, Bronzing, Wall-Paper Pasting, etc. :—

1. Nozzle.
2. Color Tip.
3. Needle Valve.
4. Color Connector.
5. Union Joint.
6. Stuffing Box.
7. Steel Sleeve Controller.
8. Spring Buffer.
9. Needle Valve Carriage.
10. Knurled ring for setting Control Barrel
11. Control Barrel.
12. Collar and Set Screw for Needle.
13. Cap
14. Needle Valve Regulator.
15. Polished Steel Ball.
16. Air Valve Glands.
17. Independent Valve Seating.
18. Air Line Connector.
19. Air Valve.
20. Trigger.
21. Air Channel to Nozzle.

Color Cup or Pressure Paint Pot attachment can be adjusted in any position left or right side and on top.

Fig. 60.

of the needle valve (3) allowing colour to flow through colour tip (2), at the end of which it meets the vacuum created by the air stream, and is then (atomized) broken up into thousands of minute particles which coalesce upon meeting their object, and form a perfectly level, smooth and even surface.

CONTROL.—The trigger control is very sensitive, giving a spraying range from a fine line to the fullest flush of the instrument's capacity. For automatic control it is only necessary to adjust regulator (No. 14).

Fig. 61.

CLEANING.—By unscrewing union nut (5) the complete fore-part may be removed for cleaning without interfering with any other part of the mechanism, therefore the operation of cleaning is always quick and thorough, even when sticky, heavy liquids have been used.

The movement for the above sprayer applies to all "Invincible" sprayers. Type "A" for artists, miniature tinting, black and white process work, etc. Type "B" for Christmas and show card work, etc. Type "C" for ceramic work, posters and so on.

A cheaper series is also made which, whilst lacking some of the refinements of the standard models, are reliable, and soundly made instruments.

The patentees and manufacturers of "Invincible" Air Brushes are the Air Brush Manufacturing Co., Ltd., Pneumatic Works, 13, Arlington Street, Rosebery Avenue, London, E.C., who also provide all accessories for complete spraying installation, such as air-compressors, air-receivers, air valves, reducing valves, condensers and clarifiers, pressure paint pots and paint pot stands, exhaust benches, fans, turn-tables, automatic cut-outs, motors, etc., of which complete details will be sent upon request.

The Midland Sprayer.

From what has already been said, it will be obvious that the most important part of a spraying plant is the correct construction of the actual sprayer or spraying pistol. The

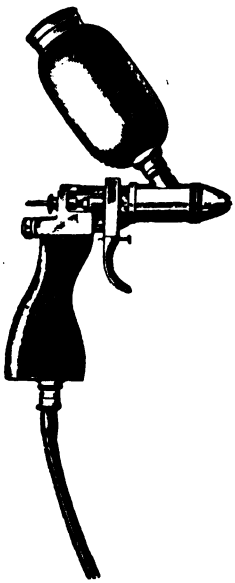

Fig. 65.—The Midland Sprayer.

Midland Fan Co., Ltd., of 46, Aston Road, Birmingham, have placed on the market a sprayer which is shown in Fig. 65, and this, we learn, has given a great deal of satisfaction. Its principal claim to superiority is the simplicity of construc-

tion, for one reason because the sprayer may be used by those who have but little knowledge of mechanics. The construction permits of easy cleaning, which is of vital importance, and for this purpose the needle can be removed by a turn of the fingers and replaced with equal ease. The illustration shows the larger pistol, and it may be mentioned that smaller sizes are made for finer work.

THE PAASCHE AIR BRUSH.

This spraying machine is manufactured by the Paasche Air Brush Co., 9, South Clinton Street, Chicago, in various sizes, for spraying by compression air liquids of all kinds.

Fig. 66.—THE "PAASCHE" SPRAYER.

The above illustration shows what is known as the "Three in One" quick action model "S" brush, and is recommended for use with heavy material. Instead of the paint pot being at the top an underslung jar with aluminium cover as shown on the lower part of Fig. 67 may be used. This figure shows the same air brush or sprayer with one gallon container; in either case the spraying of the colour or material is quickly done The flow of the liquid is entirely independent of the air circulation. An agitator is provided to keep the material well stirred, and should be used with all liquids which have a tendency to settle, such as bronzes, enamels, paints, etc. The coupling or taper stem of the flexible metal tube or bottles are easily detachable, and one material after the other can be used

without stopping. If the underslung jar or the gravity pot be used no agitator in necessary.

This instrument is made in much larger sizes. The general form of apparatus is shown in Fig. 68, the special finishing hood with exhaust fan being in this case employed, while a paint container is suspended on an adjustable stand. In this case a chair is shown being painted.

A somewhat novel apparatus for separating oil and water is that shown in Fig. 69. This is constructed to obviate the trouble which is sometimes caused by the oil

Fig. 67. Larger Size "Paasche."

and water in the air main mixing. It is connected at the end of the air main as close to the air regulator or air outlet to the brush as convenient. Oil gets into the air main through the piston of the compressor, and will in time saturate the walls of the air pipes. The condensation of water which is due to changes of temperature makes the iron pipes sweat, and a considerable amount of water is accumulated in this manner. The simple appliance shown in the illustration will remove this.

Fig. 70 shows the Paasche Automatic electric controller which is used for automatic starting and stopping motor driven compressor outfits where from ⅛th to 1 horse-power motors are used.

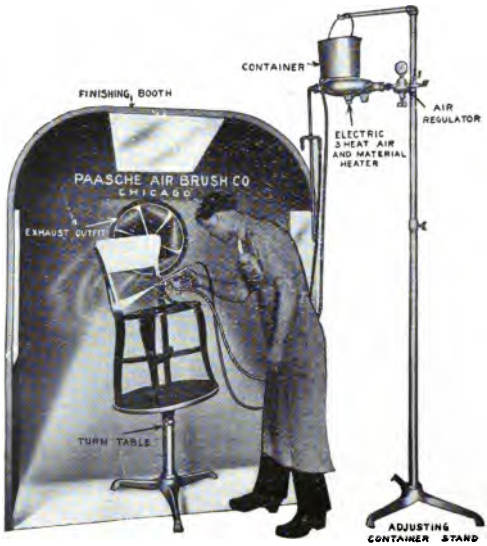

Fig. 68.—General Form of "Paasche" Sprayer.

Fig. 69.—"Paasche" Oil and Water Separator.

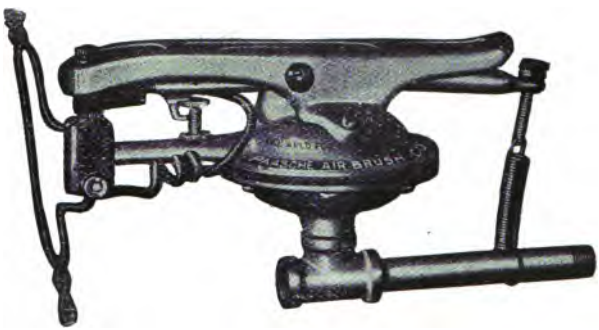

Fig. 70.—"Paasche" Automatic Electric Controller.

CHAPTER VII.

SUPPLY OF COMPRESSED AIR—PAINT SUPPLY—EXHAUST.

The forms of spraying apparatus having been selected, consideration must next be given to the following details, viz. :—(1) The supply and degree of pressure of the com pressed air. (2) The form and location of the paint supply. (3) The arrangement of an exhaust installation to carry away the fumes and waste paint. These will be dealt with in their order.

It is clear that attention has to be paid to a convenient arrangement of reducing valves controlling the pressure of air to the sprayer, and also providing, what is in many cases indispensable, a pressure feed of colour to the sprayer, either from a large pot mounted over the hood, or a special type of bowl screwed on to the sprayer.

Some makers still advocate a simple type with small bowl screwed on to the sprayer, and no means of controlling the pressure save by adjusting the safety valve on the main tank, thus necessitating that each operator shall work at the same pressure, arguing that reducing valves, pressure feeds, etc., etc., are unnecessary refinements, but it may be safely claimed that such opinions are made without due consideration of the advantages of the more complete system, and that the consensus of opinion is in favour of such refinements, giving, as they undoubtedly do, a further increase in speed, and, in many cases, making practicable what would otherwise be impossible, as well as ensuring that whatever work is to be done, the most suitable pressure is instantly available.

In the equipment of an efficient compressed air plant for painting, the type of compressor employed, and the arrangement of the air main, should first be decided upon.

The compressors must be designed to give an absolutely pure supply of air free from oil or grit, and the air-main must be so arranged as to avoid any trouble due to con-

densation. This is overcome, first, by using, at least for high-class work, a horizontal air compressor, water cooled, with a sensitive sight-feed needle valve lubricator to the cylinder, capable of delicate adjustment, so as to avoid excess of lubrication. Needless to say, the machining of the cylinder, piston, etc., of the compressor must be of the highest class to ensure satisfactory running under such conditions. Then a suitable air filter must be fitted to the intake of the compressor. This filter should be of large diameter, and have a gauze screen and wad of cotton wool.

The air valves should be so arranged that they may be removed without breaking the water joint, and be so arranged that they may be taken out and replaced in a few seconds.

The main tank must be provided with safety valve drain cock and pressure gauge, and the air main, of not less than ¾ in. diameter barrel, preferably steam barrel, must be arranged to travel in a downward direction from the main tank towards an end station tank, which is a duplicate in miniature of the main tank or receiver. All branches must be taken upwards off the main. Such an arrangement, if care is taken that the end station tank has its relief valve set to blow off before the main tank safety valve acts, ensures that all moisture is collected in the end station tank.

The Airostyle and Lithos, Ltd., claim to be the originators of such a system, and it is here explained in print for the first time.

All experiments with a view to scrubbing or purifying the compressed air of moisture, oils, etc., on the air main side of the main tank, other than the above simple expedient, have proved more or less failures, either from want of appreciation of the increased capillary attraction set up in the tanks and air main, or from the difficulty of satisfactorily and frequently cleaning out such scrubber as may be inserted, and the incidental difficulty created in the prevention of dust being carried out of the scrubber throughout the system.

It need hardly be said that ample air must be provided in order to have sufficient pressure always available for the full number of operators employed, and this point is one which cannot be too strongly emphasized, for in too many cases firms have installed small compressors and have been misled as to their maximum capacity, mainly through over anxiety on the part of the salesman to secure his order for apparatus, he apparently having been afraid to ask a high figure for a really efficient compressor.

Fig. 71.—AIROSTYLE AIR COMPRESSOR.
[CAPACITY 40 CUBIC FEET PER MINUTE.]

Fig 72.

Fig. 73.

Fig. 74.—DEVILBISS AIR COMPRESSOR.

Another point of importance is that unloading devices, cutting in and out automatically should be avoided at all cost where compressed air is to be used for painting. The reasons are that it is much better to use the surplus air for the purpose of getting rid of the condensation in the way already indicated, and that in addition most unloading devices are in the nature of compromises, and while saving only a small amount of power materially increase the wear and tear by throwing the load in the reverse direction on the gudgeon pin, large and small end of connecting rod and main bearings, and by causing a hammering action to be set up.

This applies in particular to air compressors with automatic valves where the device works by means of a valve closing the air intake entirely, and so setting up a vacuum in the cylinder.

A much better plan is to arrange the compressor to run at a speed sufficient to give a slight reserve of air above what is needed and to have it running constantly during the whole working period.

This may seem at first sight an arbitrary attitude to take up, but it is the result of considerable experience, and need not be considered as extravagant when it is borne in mind that air compressors of more than 40 to 50 cubic feet per minute capacity are seldom employed for such work, and so the maximum power absorbed is light.

The compressor illustrated in Fig. 71 is designed and made by the Airostyle and Lithos, Ltd., and has a number of well thought out refinements, both as to accessibility and form of valve bodies and valves, and also with regard to the filtration of the air and the lubrication of the cylinder. Ring oiler bearings are employed for the crankshaft, and the compressor throughout is as carefully built as a gas engine. The makers claim that an absolutely pure supply of air is delivered by this compressor at all speeds up to 350 r.p.m.

Water cooling is employed and very ample cooling surface is provided, not only for the cylinder but also the cylinder cover is cooled, and has the valves located in pockets in same.

An air compressor is shown in Fig. 72, and another one, which is water cooled, in Fig. 73. These are made by the DeVilbiss Co.

In Fig. 74 are illustrated various forms of air compressors; a pressure gauge, safety valve and drain cock are furnished

with each receiver. These tanks have welded seams and are tested to 200 lbs. pressure.

One of the Aerograph types of power pump and tank is shown below. It is strongly built, easy working, and is fitted with metal extending rings and metal valves, which will supply enough air for three spraying painters.

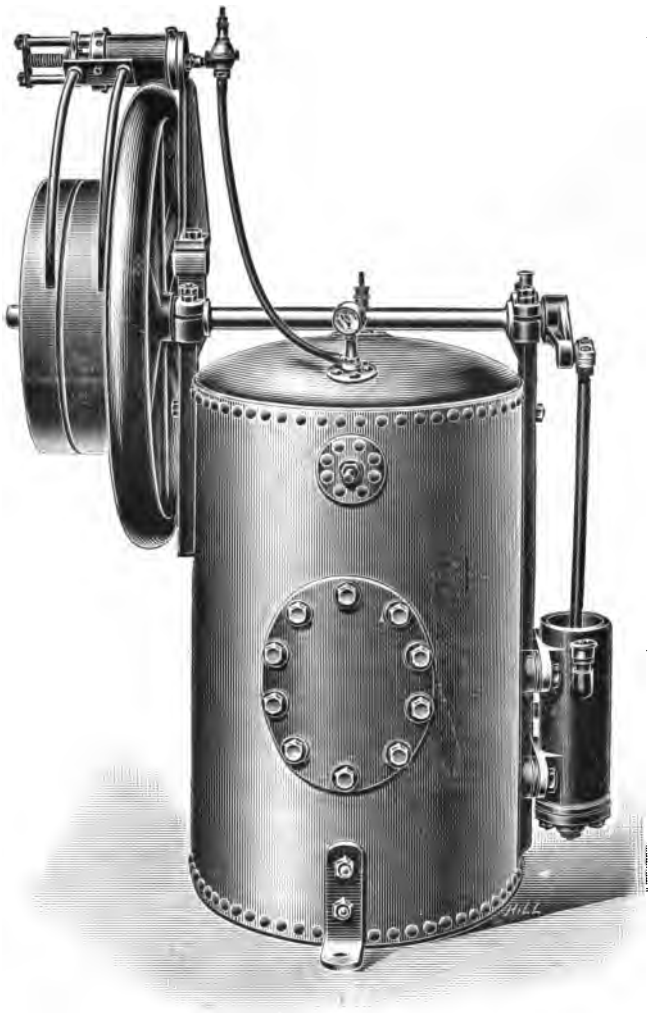

Fig. 75.—Aerograph Air Pump and Tank Combined.

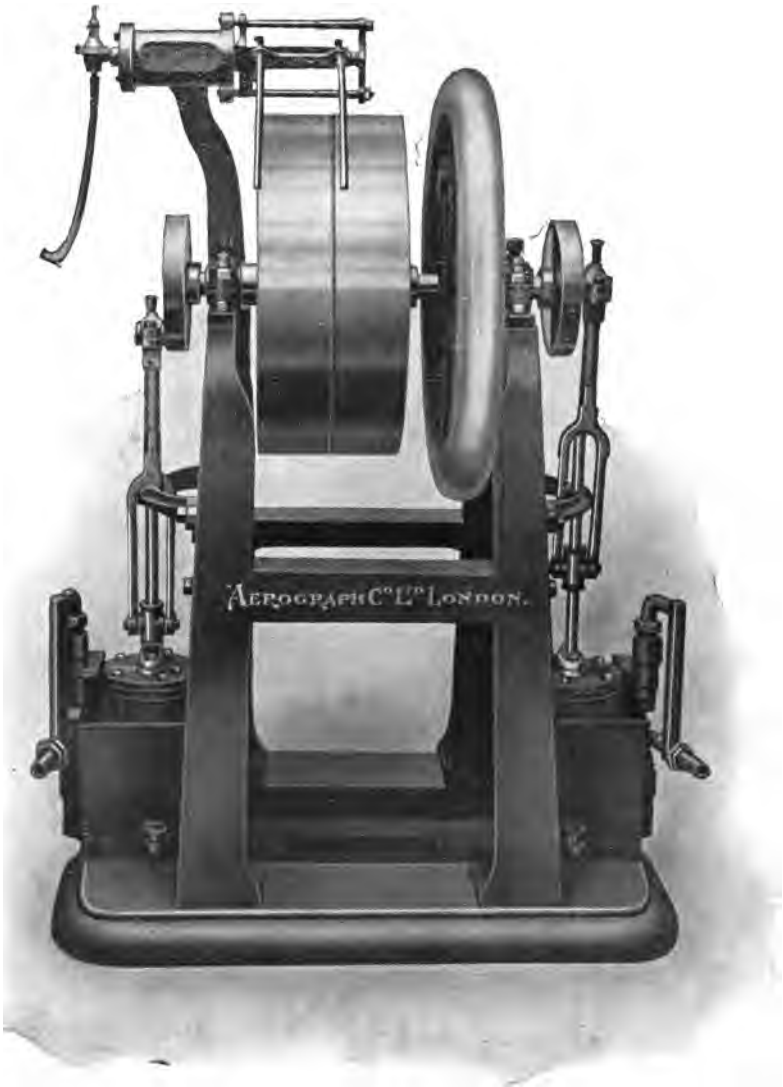

Fig. 76.—The Aerograph Type of Air Pump for Larger Installations.

In the illustration is shown the pump fitted with an automatic regulator, but this may be dispensed with if desired. The regulator, therefore, will be found of great value, not only in saving power, but also in the wear and tear of the pump. The tank is fitted with an air gauge and a speed valve, and the dimensions of the air receiver are 18 inches diameter by 30 inches high, and the pump has a bore of 3 in. while the stroke is 7 in. The power required is 1 h.p.

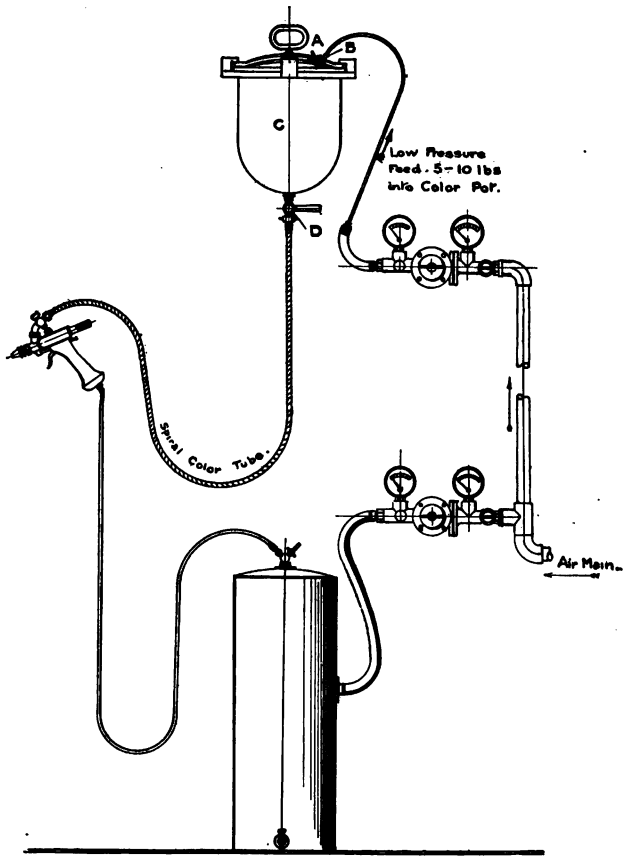

Fig. 77.—The Airostyle Plant—General Arrangement of Accessories.

The Supply of Paint.

For lacquering or coating small articles a spray may be used which is constructed with a cup to contain the paint, but for any heavy painting where large surfaces are to be covered quickly a cup on the handpiece is not of much utility, and it is necessary to provide a means to keep the supply of paint to the handpiece continuous. This is done in two ways: By an overhead paint pot, allowing gravity to carry the paint to the handpiece, or by an enclosed paint pot with a regulating valve and pressure applied to the surface of the paint by compressed air. In some situations all that is required is an overhead paint pot, the weight of the liquid feeding it to the handpiece. An enclosed paint pot has the very great advantage that (with a proper valve) the feed of the paint can be regulated to a nice degree. The paint pot shown in Fig. 77 has a damped cover which is capable of being quickly removed, and a low-pressure feed to the paint is obtained from a reducing valve. This can be set so that the paint can be forced to the handpiece to secure a uniform flow whether the paint be thick or thin.

The Exhaust Installation.

We next reach the question of arranging a satisfactory form of exhaust installation, which has been found to be absolutely essential in order to insure the health of the operator.

This exhaust question obviously opened up special problems in the direction of convenient forms of hoods or work benches, so arranged as to carry away the fumes created by the paint distributor without unduly inconveniencing the operator by reason of the draught set up.

By some firms use is made of the exhaust to collect the residue or surplus paint drawn off by employing a ventilator, which sets up a medium pressure, and interposing between the outlets of the hood and the air shaft some form of perforated screen or screens which are readily removable, or in some cases revolvable and self-cleaning.

Where slow drying japans are employed, such saving is of considerable advantage, although it must not thereby be assumed that an extravagant wastage of paint occurs, for it must be borne in mind that with a spraying plant there is no loss through evaporation from open pots and gradual drying up of the paint on the sides of the pots, or absorption of same in the brushes employed. Actually,

therefore, although it would appear that considerable wastage occurs, yet in practice it is found to be economical, and even where intricate forms, such as cycle frames, wheels, carriers, etc., or bedstead work are to be dealt with no undue loss is experienced, and such small loss as may be noted is compensated for ten times over in the saving of time effected.

When selecting a ventilator for the plant, the fact must not be overlooked that the fine particles of paint, etc., drawn off by the ventilator gradually coat the blades of the fan, sufficiently to materially increase the friction, and to absolutely prevent the exhausting of the air should multiple bladed fans be adopted.

Experience has shown, therefore, that for such work as compressed air painting multiple bladed fans are to be avoided, even though these are scientifically designed and admirable for many classes of exhaust work.

Not more than 8 to 10 blades should be employed, and there must be no belt-drive taken through the air shaft, this being a source of continual annoyance in addition to creating a loss of efficiency.

Where simple impellor fans are used, long spindles should be employed permitting an outside drive, but a better type of fan is the central draught type, preferably ball bearing, as these run for years with no attention save occasionally filling up with grease and periodical cleaning.

It may be argued that many of the foregoing remarks are not properly within the scope of this book, yet on further consideration it must be conceded that they all have a bearing upon the ultimate efficiency of the installation, and are the outcome of years of experience.

When arranging a compressed air painting plant considerable thought must be given to the most convenient position, and where stoves for artificially drying on the paint, japan, etc., are employed, care must be taken that a sufficient number of these stoves are provided to give the plant full scope, for a very material saving per annum is effected, additional to that accruing through the labour-saving effect of the apparatus, by the fact that the stoves are filled more quickly.

Where bulky work is to be handled, the plant must be so arranged as to give ample room for getting the work to and from the hoods.

The volume of exhaust air will depend on the character of the paint and the size of the cabinet. For large articles

a large cabinet is required, and a proportionately larger fan will be needed. From 500 to 1,000 cubic feet of air per minute should be supplied for each worker. A hurricane of air is not required; all that is needed is to keep the air moving away from the worker, and the ordinary type of wall fan may be sufficient for a simple installation, but cannot be used for large plants.

Airostyle Central Draught Steel Plate Fan.

This fan is designed and made by the Airostyle and Lithos, Ltd., and is invariably specified in all their medium and large installations for compressed air painting. It is very carefully designed and built specially for the work, and is fitted with ball-bearings.

As will be seen from the illustration, Fig. 79, it is worth serious attention on the part of intending users.

It is made in many sizes, from 2,000 to 23,000 cubic feet capacity, and is very largely used, not only for Airostyle plants, but also for general ventilation work.

Fig. 78.—The Paasche Motor Driven Fan.

In the above figure is shown a motor-driven propeller fan manufactured by the Paasche Air Brush Co. It is made in various sizes, varying in air delivery from 1,200 to 10,000 cubic feet per minute.

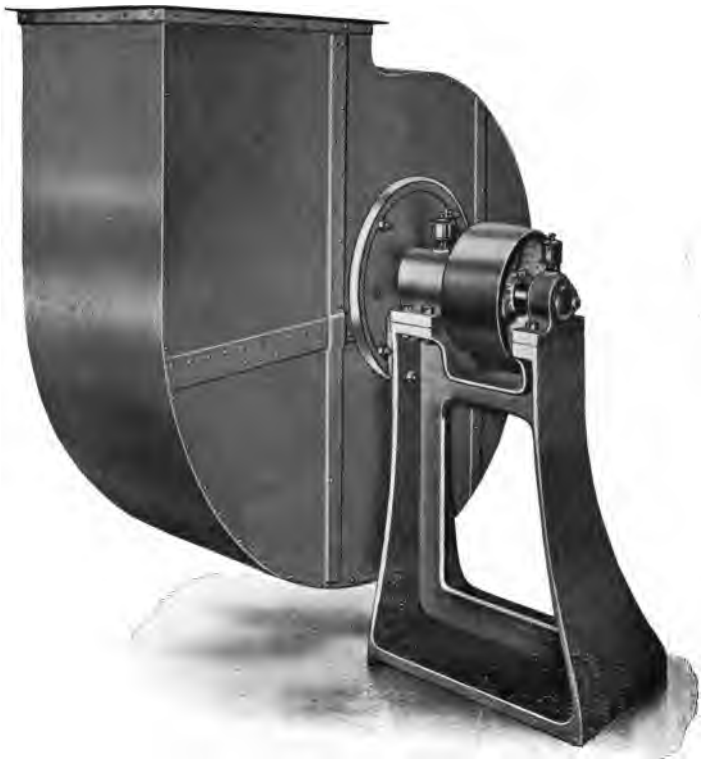

Fig. 79.—The Airostyle Centre Draught Steel Plate Fan.

Fig. 80.—The DeVilbiss Auto Cool Electric Exhaust Fan, Closed, and Open for Cleaning.

Location of the Work Cabinets.

As to the position of the spraying benches, it is a little curious to note that in not a few cases these cabinets are placed facing the window, the idea being to obtain as much light as possible for the process. A moment's consideration, however, will show that this is not the correct position, because the workman faces the light, which is thrown on the back of the article he is spraying, in exactly the wrong position for his purpose. The cabinets should be lighted from the back of the workman and be, as far as possible, directed from the roof or the top of the room, so that it

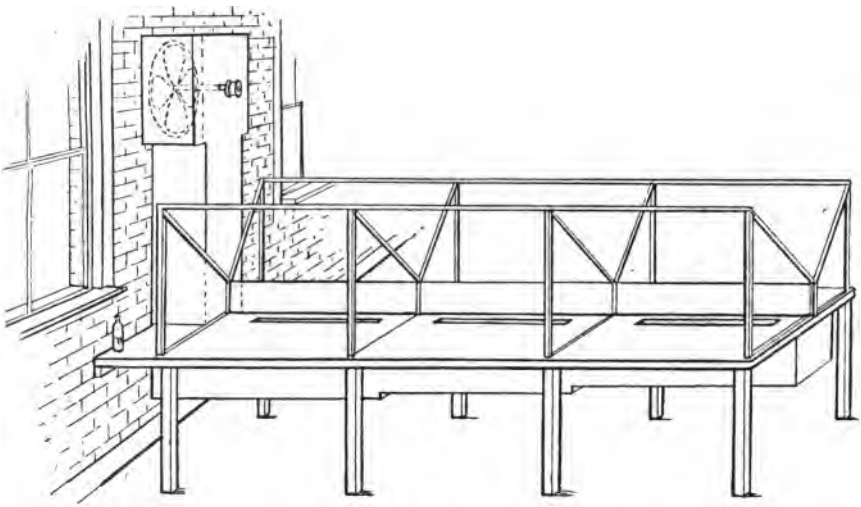

Fig. 81.—Sketch of Spraying Cabinets, Showing side Lighting.

comes directly on the article to be sprayed. Clearly it is necessary to provide as good a light as possible in order that no part of the work shall be missed.

Artificial light will, as a rule, be provided for working on dark days and after the sun sets, and here again the same provision must be made. Plenty of light arranged in such a manner that it is directed on the front of the object to be painted is essential in every case.

After due provision has been made for a suitable exhaust, which question should be left in the hands of the specialist in compressed air painting if satisfaction is to be guaranteed, other questions need attention, such as provision of means for handling the work, special turn-tables, which should

be ball-bearing, if possible, to ensure light running and enable even heavy articles to be turned about when spraying, and when examining the work.

Fig. 82.—"AEROGRAPH" SPRAYING CABINETS.

THE FUMEXER.

In connection with the Aeron, the makers supply a special form of cabinet or booth, made of steel, which is called by them the "Fumexer," and is illustrated in Figs 83 to 89.

These are made in various sizes, from 3 feet to 16 feet wide, and 4 feet to 18 feet deep. They are each fitted with turn-table and specially constructed fans for drawing out the air, and with it the superfluous paint, enamel, etc.

Fig. 84 shows a side view of an 8-ft. Fumexer indicating the style of construction and funnel-shaped back clear to the floor.

The steel Fumexer with the Autocool electric exhaust fan installed is claimed to insure a maximum exhaust efficiency, and to completely remove all fumes arising from the work in the finishing room—at a minimum of power consumption.

The Fumexer is a fire-proof steel booth specially designed and built for the height of service. It is constructed of heavy sheet steel on an angle iron frame, with wire glass windows in sides and top. Provision is made for electric lights—reflector and sockets being built in.

The back of the Fumexer is funnel-shaped clear to the floor, which arrangement, together with the large fan opening, gives maximum exhausting results, especially on large work. The short exhaust pipe running from the back opening is easy to clean and permits of the placing of the Fumexer near outside wall.

To take care of all classes and styles of work, the Fumexer is regularly made in a variety of sizes as above mentioned with the proper number of fans installed. Other sizes to meet any special requirements are made to order.

A turn-table, which is adjustable, tilting and revolving —either floor or suspended type—is supplied with the Fumexer. This device facilitates the handling of a large percentage of work. The floor type turn-table is not fastened to the floor nor Fumexer and can be removed when not required.

The Autocool electric exhaust fan installed in all Fumexers is an exclusive Aeron system product, and is particularly adapted to the work required of it.

In Fig. 85 is illustrated the side and front views of a 4-foot single exhaust fan installation Fumexer with suspended type turn-table

The fan motor, completely enclosed and protected from fumes, is automatically cooled by a stream of pure air which is continuously drawn through the motor. This means a fan of increased efficiency. The motor is only one-twelfth H.P. and will do the required work at one-tenth or less the power consumption of other styles of exhausting methods.

Autocool fans are made in one size only, the number of fan units being increased for Fumexers above five feet in width. In this way the right number can easily be adapted to any kind of work. The makers claim that by this arrangement a better distribution of exhaust is obtained, and the vapour is moved quickly at low pressure through the large fan openings—this accounting for the small amount of power used.

The next illustration shows the Autocool electric exhaust fan both closed for use and with motor and blades swung inward for cleaning.

In Fig. 86 is shown a special Fumexer with three exhaust fan installation and automobile body.

This equipment, together with type D Aeron with V spray head or type M Aeron with V-A spray head and the air transformer set, is used for priming and surfacing automobile bodies.

Two very interesting illustrations are Fig. 88, the one on the left being a Fumexer with automatic elevating and revolving turn-table, while that on the right is a Fumexer with wheel-jack.

The turn-table is revolved by a ⅛ H.P. electric motor, furnished in either direct or alternating current. The speed of rotation is adjustable through a wide range by means of a friction wheel and disc. The table is started and stopped by either hand lever or foot pedal entirely independent of motor.

A ten-inch elevation of the table is accomplished by compressed air acting on a piston which supports the revolving parts. A hand lever controls this feature, and the speed of elevation and lowering is adjustable for different classes of work.

This turn-table is especially designed for handling box-like work, finished inside and outside in the same or different materials. The elevation feature makes possible the painting of an article one colour inside and another outside in one operation without interference. It is also well adapted for use on other classes of small work.

The Fumexer in operation is shown in Fig. 89

Fig. 83.

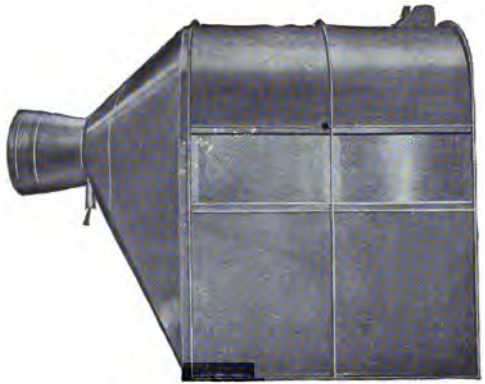

Fig. 84.

Fig. 85.

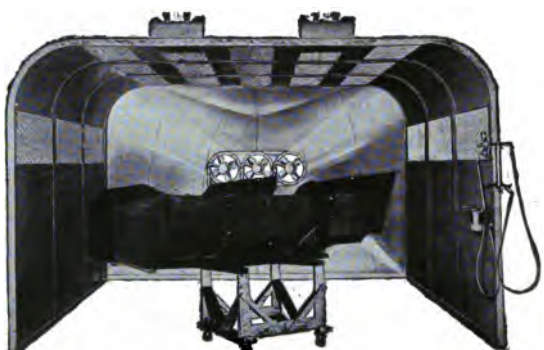

Fig. 86.

THE DEVILBISS "FUMEXER" OR SPRAYING CABINET.

ACCESSORIES.

It is difficult to classify accessories as readily as the sprayers themselves; we must content ourselves with a description of some of these as supplied by the firms mentioned in the previous chapter.

One of the most complete plant supplied is that installed by the Airostyle & Lithos, Ltd.

They have, in addition to the sprayers, a system of carrying a specially designed colour pot on a bracket over the hood clearly seen in Fig. 77. Such a colour pot has a clamped cover, making an airtight joint, and so arranged as to be readily taken off for cleaning or re-charging, and with a spun copper container, offering no obstruction to the flow of the paint and reducing loss to a minimum. Connections are provided on the top for the pressure feed, for filling up by means of a funnel, and for permitting the use of the compressed air as a means of driving out the paint from the flexible tube before leaving the instrument after work is finished each night.

Another accessory is a smaller pressure bowl made to screw directly on the pistol sprayer and designed to make possible the use of many coloured enamels, while still retaining the advantage of the pressure feed. Pressure is conveyed into the bowl through a flexible tube from a special type of reducing valve, shown in Fig. 77.

This illustration shows the connections as universally employed on Airostyle plants.

The reducing valves are so designed as to give in case of the top valve a pressure up to 15 lbs. for the pressure feed, and in the lower one any pressure instantly from atmospheric pressure up to the maximum.

It is the practice to take the air pressure from the air main through the reducing valve into the low pressure tank, as shown, as this further ensures that absolutely pure air shall be delivered to the sprayer and a steady supply of air at any pressure is always available.

The low pressure tank is, as shown, a very simple type, albeit soundly made, and a drain tap is provided at the base of same.

Last, but not least, comes the type of flexible tubing employed, and this is the outcome of much experimenting, in that the same is unaffected by the action of turpentine, white spirit, or even naphtha.

Before leaving this question the reader is referred to the numerous illustrations (see pages 155 to 185), as these give a

far better idea of the completeness of the Airostyle plants than is possible in this chapter.

TURN-TABLES.

To facilitate handling of goods to be sprayed, a turn-table is usually found of considerable service. These turn-tables vary according to the class of work that is being dealt with. In Fig. 87 is shown one made by the Aerograph Co., Ltd., which is 20 inches in diameter by 12 inches high. It is made entirely of cast iron, excepting the cone seated bearing, which is of hardened steel, which rotates freely and is nicely finished. The weight is 98 lbs. Sometimes turn-tables are provided with protecting points to prevent the article being sprayed from moving, while in other cases the top of the table is provided with ridges for the same purpose.

In all small turn-tables a conical bearing of hardened steel, properly lubricated, is sufficient for the purpose, but in the larger work it is desirable to employ ball-bearings. Whichever method is used, it is essential that the table turns very freely so that it can be moved almost with a touch.

Fig. 90 shows the Paasche turn-table, which can be raised or lowered into suitable positions as well as tilted

Fig. 87.—AEROGRAPH TURN-TABLE.

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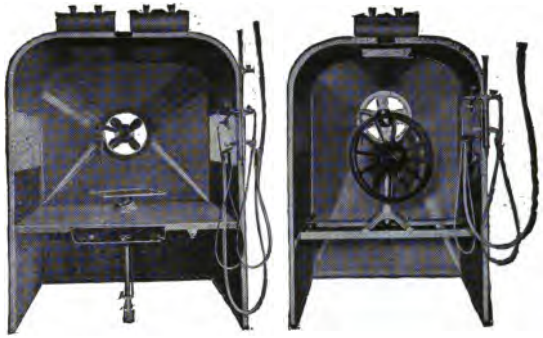

F.g. 88.—Two Forms of Fumexer.

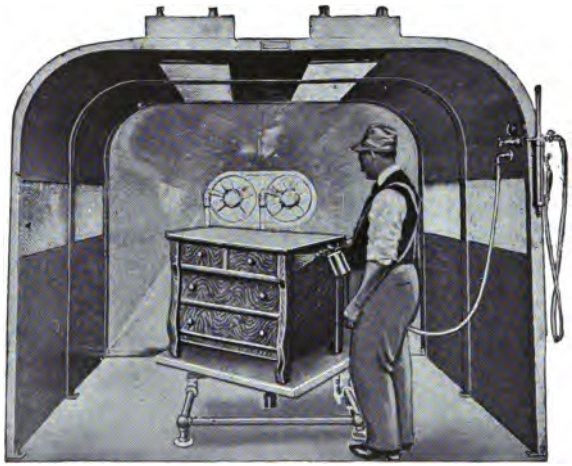

Fig. 89.—The Fumexer in Use.

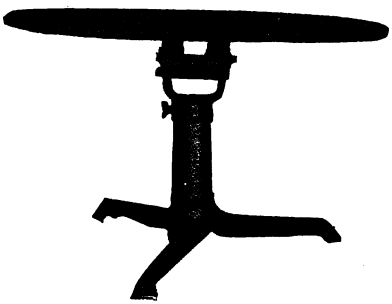

Fig. 90.—A Paasche Turn table.

at any angle. It revolves freely with a gentle touch. Larger sizes are supplied. The necessity of providing for carrying off the fumes which arise in paint spraying has already been dealt with.

The Auto-Electric Air Heater.

This invention is the property of the De Vilbiss Manufacturing Company, and is intended to overcome the tendency of the air to cool as it leaves the nozzle in spraying, while it tends to keep it heated till it reaches the work. It also raises the temperature of the varnish or enamel, producing a smooth, even finish.

In addition to heating the air, the auto-heater warms the nozzle, thereby raising the temperature of the varnish. Because of the heated air and warmed material there is a complete elimination of the pitted, pebbled or mottled effect so noticeable when "short oil," quick setting or heavy bodied varnishes or enamels are sprayed on flat surfaces. The auto-heater enables Aeron users to improve the quality of many classes of work—in many instances it opens up an entirely new field of usefulness. The auto-heater and the air transformer set together insure clean, dry and warm air at the proper pressure, which is an important factor in the production of the best Aeron results.

The auto-heater applies the heat at the last possible point before the air enters the Aeron; as a consequence there is absolutely no loss or waste of heat, as would be the case if the air were heated at some other point and then passed through the hose to the machine. It is very easy to understand that if air heated before entering the hose retained sufficient heat to be of service when reaching the nozzle, it would be so hot that it would destroy the hose. In the only practical way, the auto-heater maintains the heat in the air t the proper degree till the spray reaches the work.

The auto-heater is light, yet rugged in construction. It has no exposed contacts. The conductor wires run through the air hose. It can be attached to any style of Aeron without difficulty. There is an automatic cut-off furnished with every auto-heater. Placing the Aeron in the cup holder, or anging it on the hook, automatically cuts off the current—picking up the Aeron automatically turns on the current. This automatic control effects a great saving in current. As a protection against overheating the auto-heater is equipped with a fusible safety disc, which

melts, allowing the air to escape, if current is left turned on by accident when the Aeron is not in use. This safety device operates within four minutes. Several extra discs are furnished with every outfit. The auto-heater can be connected to any electric light socket, and consumes only 250 watts current when in operation.

The construction of the auto-heater will be understood on reference to Fig. 91.

Another interesting heater is supplied by the Airostyle & Lithos, Ltd., a number of which are in use in this co untry Its general form can be seen on reference to Fig. 102, page. 165, which shows a gas-heated type. The same heater i salso supplied either electrically or steam heated.

In all types it has the same general features, namely, a water-jacketed colour pot, a special coil for heating the air supply, which is afterwards passed through the water jacket for the dual purpose of raising the temperature of the jacket and damping down the air temperature at the same time. To a convenient standpipe the hot air is carried and distributed to the pistol, and also to a special jacket round the colour tube.

The Airostyle pistol is provided with an adjustment which admits of the hot air by-passing the whole time so, maintaining the pistol at the same temperature as the colour pot and ensuring a steady flow of the japan.

The heaters are mounted on a stand at the side of the hood and are complete with pressure gauges, regulating valves, special burner for gas, or an electrically heated pot giving three heats, or for steam giving a wide range of temperatures controlled by the steam pressure through a reducing valve. It must be explained that the same result is obtained no matter which form of heater is employed, and that in no case can the japan be burnt. The heaters are used for thick black tar varnish, or cycle japans, also for certain gum or glue mixtures and special varnishes.

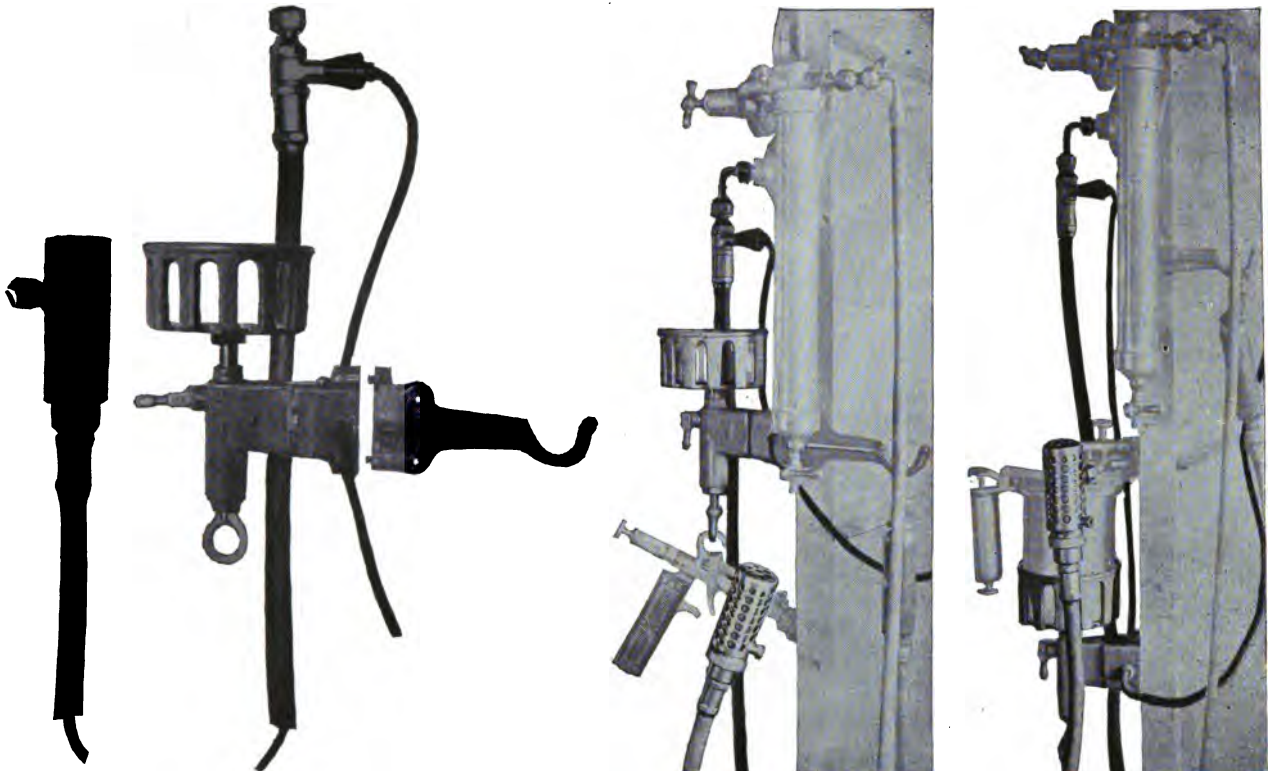

Fig. 91.—The Auto Electric Air Heater.

CHAPTER VIII.

Stencils and Masks—The Requirements of Different Trades in Spraying.

Just as in applying paint by immersion some parts which are not required to be painted can be protected, as already explained, so in spraying.

Certain parts are to be left unpainted, such as the plated fronts and glass lenses of cycle lamps. This is effected by the adoption of some system of masking. Such masks are, however, very simple and are sprung on with a simple wire spring or clip, and so held in place while spraying.

A mask has been designed and patented purposely for use when spraying. This is described on page 143. This mask has embodied in it a plunger on the end of which is mounted a rubber sucker, and as the plunger is controlled by a spring, all that is necessary to do is to depress the plunger down on to the lamp, box, or whatever article is to be painted; and as the sucker of the plunger comes into contact with the article first, it grips the surface and the spring behind the plunger forces the mask, which may be any shape, but is preferably of box form, down upon the article. This mask is very practical, but its use is limited, to some extent, to forms of lamps which do not need any stencil or mask. Such a step, needless to say, has only been taken because the system of compressed air japanning is the one ideal method—and one has only to refer to manufacturers who have used it for confirmation of this.

In addition to simple masks, there are many more complicated forms, such as those in use in gas meter manufactories, where there are no fewer than half a dozen points to be masked, and in hardly any case do more than two points remain the same over numbers of meters to be dealt with.

However, this has been overcome by arranging the masks on a spring foundation, and making them capable of

sliding adjustment in two or more directions, and the time taken to fix these masks is in no case more than 30 seconds. Seeing that the time taken to brush a meter (even a small one) is not more than seven minutes and the time taken to spray one, with a superior result, is not more than one minute, there is a very considerable saving even after allowing time for fixing the mask.

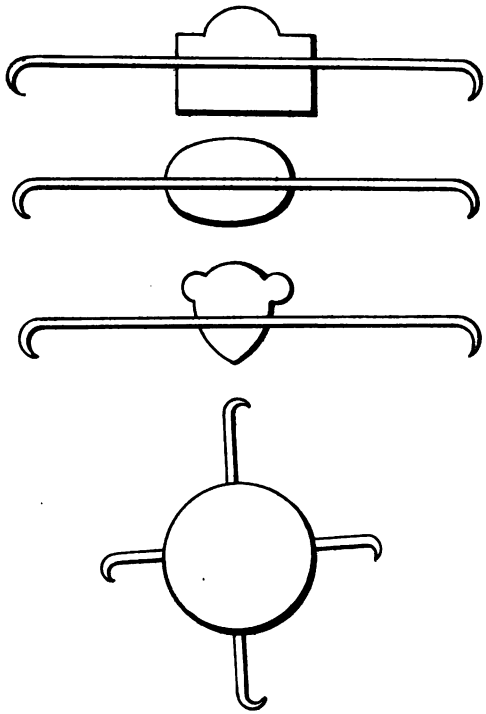

Fig. 92.—Masks for Gas Meters.

Other stencils are employed for lettering on plates, despatch boxes, and for ornamental work on cash boxes, etc., and need no further description here other than stating that these must be of something stronger than tinfoil, and not too strong to prevent them being pressed firmly down on to the article to be dealt with.

In other cases, stencils are spun or pressed out to exactly fit the article, as in the case of brass lacquered goods, rubber balls, enamelled ironware, etc., and in some cases,

where a number of stencils are employed, for one pattern, these are arranged round a common centre, and hinged so that, once the article is in position, stencil after stencil may be readily and accurately brought into position over the work.

For decorative work, very elaborate stencils are employed, with many plates for each design; but such stencils hardly come within the scope of the present work, although they are employed for wallpaper work, and in the textile industries for high-class effects.

THE HART PATENT MASK.

A very ingeniously constructed, although simple, mask which is suitable for many purposes, but particularly for motor and carriage lamps, has been patented by Mr. Walter William Hart, of the firm of Matthew J. Hart & Sons, Great Barr Street, Birmingham, and others. By this invention means are provided for applying the mask to a plain surface so that it may be immovably held without

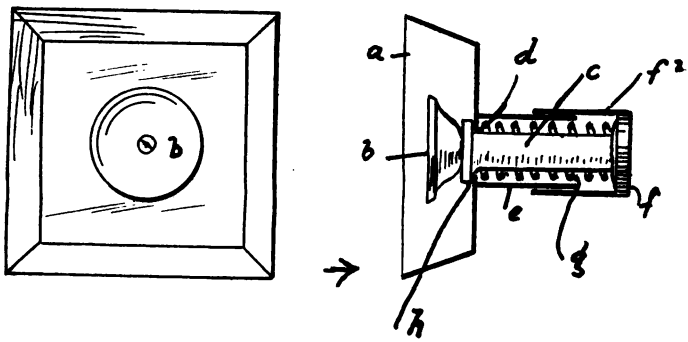

Fig. 93.—THE HART PATENT MASK.

causing injury to the surface. The mask, too, has the advantage that it can be placed in position with extreme rapidity. By this invention the mask is fastened in position by a suction pad, preferably made of indiarubber, which, when pressed on to the surface to be covered, adheres thereto by the pressure of the atmosphere. In Fig. 93 is shown an inner face view and a sectional elevation of the device. The mask (*a*) is adapted to have an axial movement in relation to the suction pad (*b*) so that when such pad has been fixed in position the mask may be pressed close upon the surface it is required to protect. This suction

pad (*b*) is of a conical formation, and is secured to the end of the plunger (*c*) which passes rearwardly through a hole (*d*) in the back of the mask, and through a tubular extension (*e*) passing rearwardly from the back of the mask. The rear end of the plunger has a hole therein, which hole is screw threaded, and to such end a cap (*f*) is secured. A stud (*f*) on the interior of the flat end of the cap screwing into the said tapped hole, and the cylindrical portion (*f2*) of the cap slidingly fitting over the tubular extension (*e*) on the mask. A spiral spring (*g*) surrounds the plunger, one end bearing on a shoulder (*h*) at the rear of the mask and the other end bearing against the cap (*f*). To fasten the mask, the same is placed in position over the part to be covered and the cap (*f*) is pressed down, thus pressing the suction pad (*b*) upon the surface of the article, to which it adheres. A mask constructed according to this invention is capable of a great variety of applications, one of which is in connection with lamps. That shown in the illustration is intended for this purpose.

It will be clear that the shape, however, can be varied according to the article to be painted by spraying; for example, it may be used with advantage for decorative purposes.

MAKING STENCILS.

When it is decided to spray through stencils, it is usual to employ thin copper plates for the purpose, although in wallpaper decoration very heavy copper stencils are used, because, these being held horizontally, the weight increases the stiffness of them, while it prevents them shifting while in use. In ordinary work, however, where a stencil must be used vertically, the lighter stencil will be most useful. If paper is used, the best material is Japanese vellum, which is manufactured from a special fibre and possesses the advantage of being easy to cut and makes remarkably durable stencils. It is imported from Japan by Jas. Spicer & Sons, Ltd., 15, Upper Thames Street, London, E.C. Manilla paper may be had from the same firm, and answers also very well. For some styles of work, lead foil gives good results. Messrs. Locke, Lancaster, and W. W. and R. Johnstone & Co., Ltd., 94, Gracechurch Street, E.C., supply a material which they call "Four-ounce stencil metal," which weighs 4 ounces to the square foot, is made in sheets 6ft. by 2ft. 6in., and in smaller sizes, and costs 2s. per lb. It can be easily cut with a stencil knife, and is

most suitable for work on horizontal surfaces. Another paper which may be used is ordinary Whatman's paper. The usual method of cutting is to use a very sharp knife, such as a shoemaker uses, and to cut on a sheet of glass. If any variety of paper is employed, it will be necessary to apply two coats of shellac varnish, ordinarily called "Patent Knotting." This protects the surface of the paper from being worn away by the action of the brush. Some stencil cutters prefer boiled oil for the purpose.

Zinc stencils are sometimes employed. These may be made as follows: The thinnest sheets of zinc are employed for the purpose, and upon this is painted the letters or design to form the stencil. The whole of the zinc which is not to be cut out, or rather, by this process, eaten out by acid, must be protected by means of a varnish made as follows: Take one pint of best asphaltum varnish, two ounces of beeswax and half-an-ounce of rosin and four ounces of Venice turpentine. Melt the beeswax and rosin in the Venice turpentine, and while warm add the asphaltum varnish, mixing thoroughly together. Paint this on the back of the zinc plate and on all parts that are to be protected. Form a dam or little wall made of 6 parts of beeswax and one part of tallow melted together and allow to cool. This is intended to confine the acid to the parts required to be eaten out. Nitric acid is used for the purpose mixed with three parts of water. This is poured on the space inside the dam and allowed to remain on for from 24 to 48 hours, when it will be found to have eaten away the zinc on the parts unprotected. Further information concerning stencils will be found in the book entitled "Stencils and Stencilling," by A. L. Duthie, published by the Trade Papers Publishing Co., Ltd., 365, Birkbeck Bank Chambers, High Holborn, London, W.C., price 3s. 3d.

REQUIREMENTS OF SPECIAL TRADES.

The following hints are given of the requirements of a few special trades :—

Piece Work.

In very many cases where articles are painted by means of compressed air it will be found quite practicable to have the work done by piece work. The exact time taken to spray any particular article can, after a very little practice, be determined quite accurately. In fixing the price to be paid for the work an allowance must, of course, be made for the

time taken in bringing the piece to the spraying cabinet and placing it ready to be taken away by the boys or labourers. It is in this detail that speed may be increased so materially. The actual time of spraying to a great extent regulates itself, but if care is not taken considerable waste of time will be occasioned in getting articles ready and taking them away, and a satisfactory arrangement of piece work to both employer and employee will remove this waste of time and will prove more beneficial than day work.

Bookbinding.

The principal use of spraying in this work is to put on the speckled edges of books after they are sewed and before binding. This is usually done by splashing colour from a stiff-haired brush over a comb, but the method is a crude one at best. In using a spray for the purpose one of the simpler forms will do all that is required. The pressure must be lowered and paint removed some distance from the books until the requisite size of the spots or dots of colour is obtained. With a little practice this can be regulated to a nicety.

Carriages.

The remarks which will be found elsewhere, under the head of "Tramcars," apply to some extent to carriages also, and although the superfine finish required for a high-class carriage could hardly be produced excepting by the old-fashioned means, yet the processes of flowing-on and spraying could, without doubt, often be employed for the cheap and moderately cheap style of vehicles of various kinds which are now produced on so extensive a scale.

Cycle Parts.

Many parts of cycles are now painted by means of spraying, although some firms prefer dipping. Whichever process is used it is necessary, as a rule, to give at least two or sometimes three or even more coats, and to get a fine finish to rub down between these coats with powdered pumice and water, and, for the last coat underneath the finish, rottenstone and oil. The parts must always be stoved, as air drying enamels are not, as a rule, sufficiently hard to permit of their resisting the hard wear to which cycles are subjected. It need hardly be said that the method of handling various parts will to a great extent determine the economy effected.

The wearing parts of cycles are sometimes finished in the following manner, which is the method used by the Birmingham Small Arms Co. Although somewhat expensive it is certainly worthy of all praise, because it gives so durable a finish. The iron or steel parts are first thoroughly washed in American turpentine and are then stoved, the result being a perfectly clean surface. A coat of Calcutta linseed oil is then given by means of brushes and the parts are then stoved at 250° F., after which they receive a coat of what is called "Black Rubber Solution," an elastic enamel which dries with a semi-gloss. Then two separate coats of khaki colour japan are given and each are stoved at 280° to 300° F. A little rubbing down between the coats is sometimes necessary, and this is done with glass paper. The parts thus finished are very suitable for work which is to be subjected to very hard wear. At this writing the cycles are all intended for Government, hence the care taken in the finish.

Electrical Work.

Painting by compressed air is done in the case of many parts of electrical apparatus, the process being similar to that previously described. Thus the metal work of fuse boxes may be finished in this way with black japan, and one coat stoved at 250° F. or thereabouts will usually be found to suffice.

Among the large number of electric works where the process is employed may be mentioned those of W. T. Henley's Telegraph Works, Ltd., at Gravesend. The Airostyle is used in this case, and the work is done approximately from twice to three times as rapidly as it was formerly done with the brush.

Fancy Baskets.

Fancy baskets which are made of cane, willow, special straw and other materials can be sprayed with admirable effect in many cases where brushing would be impossible. Indeed, the application of a spray in this work may be considered to have created almost a new industry in a wide range of fancy goods, which may be sprayed with gold paint, or a great variety of coloured enamels may also be employed. In this case celluloid varnishes are also employed with the addition of coal tar dyes for the production of colours such as mauve, blue, moss green, rose pink, amber, orange, fire red, navy blue, etc. The work of spraying in this case

is usually done over a bin such as is shown below, a simple wire device being used at the top to support the basket while it is being sprayed, although even this is often

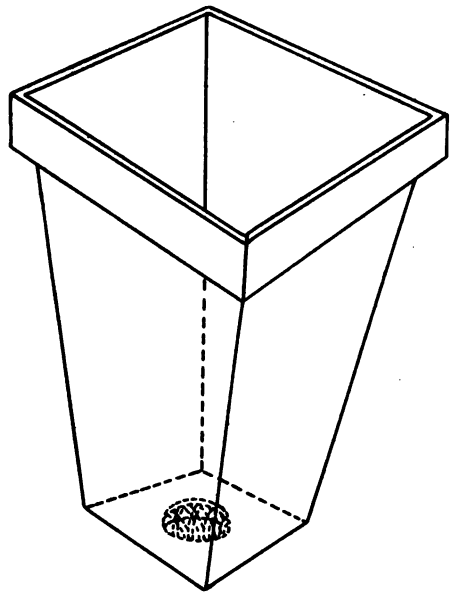

Fig. 94.—Bin for Spraying Light Articles.

dispensed with as the article may be held by the handle, and being very light this is not found to be irksome.

Gas Meters.

At the present time less than half a dozen gas meter manufacturers or repairers have a paint spraying plant in use, and these are described elsewhere. The saving, however, by spraying the paint is in this class of work very considerable, amounting to about 1 to 5; that is to say, five times as much work can be turned out with a spraying machine as by hand. It is generally recognised that the quality of the painting is much improved, it being harder and better in appearance and generally more satisfactory. Turn-tables of a simple character are employed, and 24 hours are allowed for the drying of the work. For protecting the indicators, the name of owner or manufacturer and

brass plates of similar character, various types of shields or masks are employed, consisting of a plate of requisite shape soldered on to a piece of stiff wire, with turned ends, which embrace the meter and hold it in position. There appears to be no reason why the larger size gas meters should not be painted by spraying, provided that a suitable plant, which would be of a simple character, were provided. There is but little doubt that in a little time every manufacturer of gas meters will find it necessary to employ a spraying plant.

Gas Stoves and Ranges.

In this class of work spraying is used almost exclusively; as only one side of the iron is to be painted the dipping process is obviously unsuitable. The work is done at a pressure of about 45lbs., but sometimes a little less is sufficient. The usual exhaust is provided and turn-tables are employed having bearing wheels on the outer edge of a circular plate. Those used for the larger ranges are usually level with the floor. In addition to black, all kinds of colours may be used. This work is mostly done piece work. The smaller parts, such as rings, cookers, etc., are also sprayed. The stoving is done at 350° F., but when two coats are given the first is subjected to 450° F.

The interior of the ovens are coated for a finish of oxide of tin, which when stoved at a high temperature assures a great increase of "body" or opacity. Sometimes the finish is left solid, but in most cases the coat is stippled.

The usual overhead runways consisting of hanger on four wheels on V-shaped girder are employed.

Picture Frames, Picture M ulding, Etc.

One of the industries in which paint spraying is strikingly successful is that of preparing picture frames with a "gold" finish. If properly done the result is even better than if gold leaf is used, as the spray covers completely the most elaborate and intricate ornament. Picture frames or mouldings of various shapes and sizes are obtained ready for receiving the various coats necessary to give a gold finish. Formerly the whole of the operations were done by means of brushes, but this method has been wholly superseded by spraying, which approximately does the work five times as quickly and gives a far better result.

Three separate processes are employed; the first is the application of a coat of enamel, the second a coat of bronze or "gold paint," and the third the application of a transparent lacquer. The last protects the bronze from discoloration, and the manufacturers guarantee that such mouldings will last at least 5 years without tarnishing.

The whole of the work is air dried, but to facilitate the operation the workroom is kept at a temperature of about 75°F and the drying ovens up to, say, 80° or even 85°F. The first coat of enamel is sprayed on, and in about two hours is felted down with a pad similar to that used by french polishers. This is dipped in a solvent which removes all inequalities. The actual spraying is done on a long open trough shaped bin some 3 ft. 6 in. from the floor having exhausts at the bottom and thin laths placed across it at intervals of about 18 inches. The long stretches of moulding are placed on these laths lengthwise, the laths holding them in position. The spraying is done directly on them and they are turned from side to side, and when the spraying is completed each length is lifted bodily by two boys, one at each end, on to racks in the drying room which is close by and which has a large number of open iron shelves running from end to end. These shelves are quite close together, so that a large number of lengths of moulding may be dealt with at one time. Heat at about 85°F is admitted at the bottom, and the drying apartment is open from end to end in front so that the mouldings may be readily introduced. This heat also serves to warm the room.

The enamel being dry the length is removed and gone over with a pad as described and the gold paint is then sprayed on over the whole of the work, giving a beautifully fine and compact gold finish. The application of the transparent lacquer completes the operation. The materials used in this work are special spirit varnishes made on a base of celluloid. The exact composition varies with different manufacturers, but the following recipes are based on "The Manufacture of Spirit Varnishes," by Livache and McIntosh (Scott, Greenwood and Son), and will be useful for reference. The great advantage of using celluloid is that a coloured transparent varnish is obtained.

Recipe for Celluloid Varnish.

1. Celluloid 1 lb.
   Amyl Acetate 2 lbs.

Acetone 2 lbs.
Ether (Syph. Meth.) 2 lbs.

2. Same as before with the addition of 1-5th part of camphor.

3. Celluloid 1 lb.
Amyl Acetate 5 lbs.
Acetone 5 lbs.

Picture frames are also finished in black having a semi-gloss finish, which gives an excellent effect and is most durable.

It is very important in this class of work that ample ventilation be given to the apartment in which the work is done in such a way as to avoid draught. Heated air, of course, takes up moisture much more readily than cold air, and unless means are provided for adequate ventilation the air will become moisture charged, and the work will thereby be adversely affected. This is a point which is frequently overlooked.

Spraying Ships' Hulls.

It is the opinion of the author that the painting of ships' hulls may be done by means of spraying with a great saving of time. Although there are no available statistics, it is probable that many thousands of acres of surface on ships' bottoms are re-painted every year. A careful enquiry has shown that some experiments have been made in this direction, but that they have always been of a somewhat perfunctory character. The very large surface gives an opportunity for the use of the spray which is almost unequalled in its possibilities. There are, however, certain difficulties in connection with this work, which have doubtless had much to do with the fact that it has not, thus far, been adopted to any considerable extent.

The first of these is that the composition applied is not ordinary paint, but one which is mixed with arsenic, mercury and other poisonous compounds, which are added in order to destroy animal and vegetable life and prevent the adhesion of barnacles and other marine growth. So necessary is this that compositions are made suitable for different waters through which the vessel must pass, and it is well known that those vessels which sail by regular routes need much less frequent painting than a tramp steamer which may sail in any direction and through any sea. The reason is, that in the first case the composition is specially made to withstand the growth of life in well-defined waters, while in

the case of tramp steamers it must be more or less of a general nature.

The point, however, which has now to be dealt with, is that the addition of arsenic, etc., added to the paint, causes it sometimes to settle out, but it is suggested that this could be easily overcome by an agitating apparatus in the paint pot. As explained elsewhere, such an apparatus is frequently used in ordinary painting, when the composition of the paint demands it.

The second and more serious objection to spraying ships' hulls is that the work must be done in the open, and that the wind will carry away a portion of the paint and prevent it reaching the surface required. It is suggested, however, this might perhaps be overcome by adopting a form of enclosed cabinet, which would screen the operator from the wind. This could be rendered portable by being mounted on a platform with wheels, and a system of elevators, and be adopted with a little ingenuity to reach the higher parts of the vessel. In any case, the subject is one which is well worth the attention of those interested in spraying, owing to the immense field it opens up.

In this connection attention may be directed to the illustrations which appear on pages 252 to 254 of the apparatus used for spraying by the Pennsylvania Railroad for painting their freight cars. This apparatus may be adapted, with suitable modifications, for ship painting also.

Slate Enamelling.

The usual procedure followed in connection with enamelling on slate for mantel-pieces, stall-board, signs and other work of the kind, is to get the slate slabs quite smooth and level by means of a slate planing machine. A coat of "black varnish" or enamel is then sprayed on, and is stoved at 160° to 170° F. Careful rubbing down with powdered pumice and water is next done, when the work receives a second coat of enamel. It is again stoved and then rubbed down by hand to a finish with rottenstone and oil. Sometimes the slate receives three coats, the finish being left with a high gloss, but more frequently the semi-gloss obtained by rubbing with rottenstone is preferred. It is unsafe to stove slate at higher than 260° F., as it is likely to break when cooling.

Formerly, a great deal of this class of work was done in imitation of various marbles, mostly worked on a black

ground, but "marbling" is now done but rarely. The method is to employ a shallow tank of water upon which are placed colours in imitation of the veins of the marble to be imitated. This colour is of a special kind, made to float, and is manipulated on the surface. The slab of slate, which has received one coat, is then dipped gently in the water, when the colour adheres to it. A coat of stoving varnish completes the operation

Many slate enamellers still employ the old method of applying the enamel by means of brushes, but it is only a question of time before compressed air will be used almost exclusively, for the reason so frequently urged in this work, viz., that the spray eliminates brush marks and, therefore, greatly reduces the work of rubbing down.

Spraying Colour Specimens.

Specimens of various colours in distemper, oil, varnish and enamel are sent out in very large quantities by the various manufacturers of those goods, and the preparation of these specimens may be very considerably facilitated by using a suitable spraying machine. When distemper is used fairly large sheets of paper are usually employed, and these are cut up by means of a guillotine machine when dry. Ordinary oil paint and varnish paints may in like manner be sprayed, but when an enamel finish is desired it is usual to apply the paint on the back of a sheet of thin white celluloid, which gives the appearance which would be obtained by the application of varnish. In spraying celluloid sheets it will be found that after a little practice the paint may be laid on much more uniformly than is possible by means of a brush. This can easily be demonstrated by holding up the painted sheet to the light, when it will be found that the paint applied by a brush shows more inequalities or streaks than that when sprayed.

Stencilling may be done very well on either paper or celluloid sheets; in the case of these specimens, for example, supposing it was desired that each specimen of colour when cut up should bear a number, it would not be difficult to cut a stencil in zinc or leadfoil, repeating the number as many times as there are specimens to be cut out of each sheet. The tinfoil would then be fixed in position and the spraying done over it, which would mark each piece with a number. Then the coat of colour can be sprayed all over the surface. The plan above would be followed in the case of celluloid, but when ordinary paper is used

the process would, of course, have to be reversed and the number put on last.

In some cases where a very great brilliancy of colour is required; this is done by the process of glazing, which is described elsewhere in this book; for example, a comparatively dull red could be very much brightened by spraying a coat of madder or crimson lake. Here, again, if celluloid is used the glazing colour will go on first and the ground colour afterwards, but in ordinary circumstances the ground work would, of course, be first applied.

Probably the most complete plant for preparing colour specimens is in use by Mander Brothers, the well-known paint, varnish and colou rmanufacturers, of Wolverhampton. The spraying of colours is mostly done on celluloid sheets, and four cabinets of the Airostyle type are in more or less constant use. These cabinets have glass sides and top hung on hinges so that they may be opened when desired. The pressure of air is usually from 30 to 35 lbs., with an additional 5 lbs. on the paint pot. One coat is sufficient, because, of course, it can be made as thick as may be necessary according to the particular specimens being prepared. The saving of time is estimated at, at least, 33 per cent.

In dealing with celluloid sheets it is obviously of importance to adopt some safe means of storing them while drying. Formerly Messrs. Mander Brothers had a long series of double clips by which the sheets were suspended while drying, but this method has been abandoned owing to the danger involved of fire. Now suitable tin-lined cabinets are provided having from top to bottom a series of cleats which support open wire trays. Each sheet of celluloid as it is painted is placed on a wire tray which is slipped in the cabinet, where it dries in 12 hours.

TRAMCARS.

As far as the author can gather information, the processes described in this book are not used in Great Britain to any extent in the finish of tramcars, but are gradually making headway in America, particularly for the final coats. There appears to be no reason, however, why "flowing-on," as described in Chapter XIII., should not be used to a much greater extent than is at present the case. The earlier coats, being very stiff, might be applied by means of brushes,

Fig. 95.—General View of Aircstyle Plant for 16 Operators on Small Work.

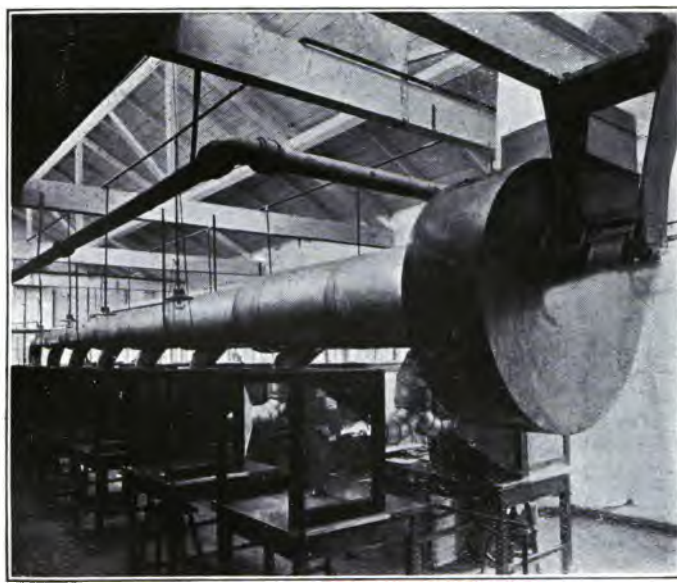

Fig. 96—View of Airostyle Plant for 16 Operators, showing Ventilator.

and these coats could be followed by spraying, and finally the finishing coats could be flowed on.

Formerly, this work was done almost in the same way as that by which the fine finish of a carriage body is produced, viz., the building up of a perfectly smooth surface by a large number of coats, rubbing each one down carefully and finishing with two or more coats of varnish, these being also rubbed down excepting the last.

In modern practice these methods are greatly simplified, and at least several coats, which were formerly thought to be necessary, are dispensed with. The finish is often obtained by applying a coat of a suitable enamel, rubbing this down, and then giving a final finish of a good flowing varnish.

It is suggested that spraying, or flowing-on, could be used for some of this work with very great advantage in the saving of time.

In dealing with many paints which are to be stoved, a well-thought-out system should be in use of conveying the articles from the finishing rooms to the painting apparatus and thence to the ovens. If more than one coat is given it will be necessary to arrange also for conveyance after the parts are baked back to the painting plant for the next coat.

As a rule, a system of overhead runways, such as is described for use in paint dipping, will be found the most economical method to adopt.

It will be observed that in the list of trades and articles which may be successfully painted by mechanical means, given on pages 3 to 6, there are many which are omitted from the detailed descriptions. The reason for this is that the main principles are in all cases practically the same and the details must necessarily vary, not only with the goods being dealt with, but according to the extent of the operations and the accommodation of the factory available.

Thornley & Knight, Ltd., of Birmingham, specialise in this business, and have sold, during the last few years, many thousands of gallons of their air-drying coloured japans, for use on car bodies. Many of the largest motor car manufacturers have adopted the process.

CHAPTER IX.

Some Typical Plants.

An interesting Airostyle plant is shown in Figs. 95, 96 and 101, and is arranged for 16 operators to deal mainly with bronze lacquers, hence the somewhat simple arrangement with no provision for adjustment of pressures at each hood.

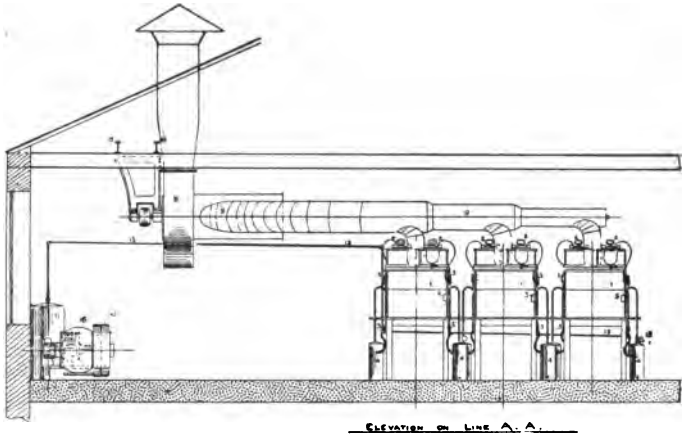

Fig. 97.—Side Elevation of Plant for 12 Operators.

It will be noted that the ventilator employed is of important size; the compressor delivering air to the plant is stationed in the basement.

The views of the plant are excellent, and serve to remove the erroneous impression that such a plant cannot be conveniently and economically arranged, both as regards floor space occupied and the provision of adequate gangways on all sides.

Another interesting Airostyle plant is shown in Figs. 84, 85 and 86, and was installed for japanning gas fires, radiators,

gas cookers, etc. An item worthy of note in this plant is the patented hot air apparatus installed for warming the japan and for also heating the sprayer and flexible tube conveying the japan to the sprayer; it is clearly seen in the centre of the two hoods. The large hood is mainly used for radiators, which are wheeled on to the large ball-bearing turn-table, shown white for the purpose of a clearer view, but when not so used a table is wheeled into position and two operators are accommodated for smaller work.

The power unit, consisting of electric drive and suitable overhead countershaft, together with the compresser and

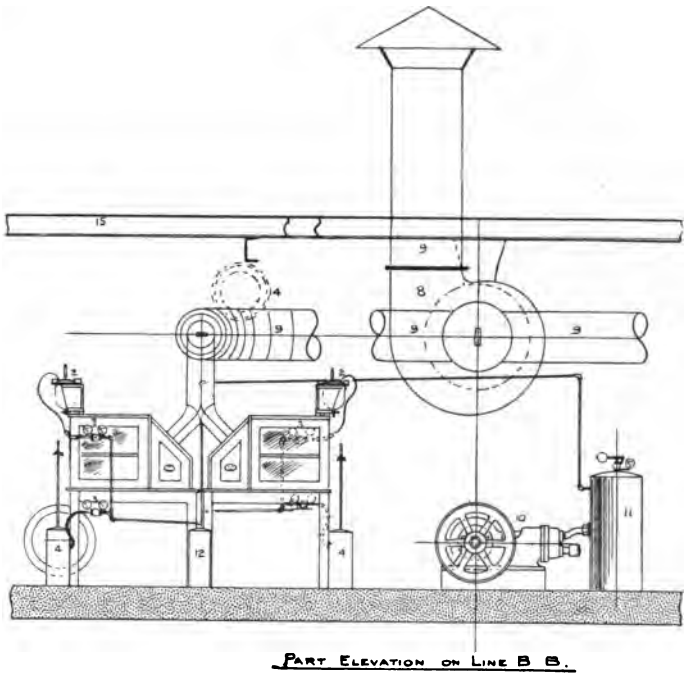

Fig. 98.—PART END ELEVATION OF PLANT FOR 12 OPERATORS.

ball-bearing fan, is shown in Fig. 100, and is directly outside the japanning shop.

This plant was installed for the Davis Gas Stove Company, Luton, and has been in operation for several years.

The compressor shown in Fig 98 also delivers air to the gas cooker department for two or three operators.

and to the porcelain enamelling department for six or seven operators, but as the same practice is adopted as is shown in the photos here reproduced, no useful purpose will be served in describing them in detail.

Undoubtedly one of the most important plants in the country, and one producing the highest finish, is installed at Messrs. Joseph Lucas, Ltd., Birmingham, and the photographs reproduced here are by their kind permission. The author was granted the privilege of inspecting the plant

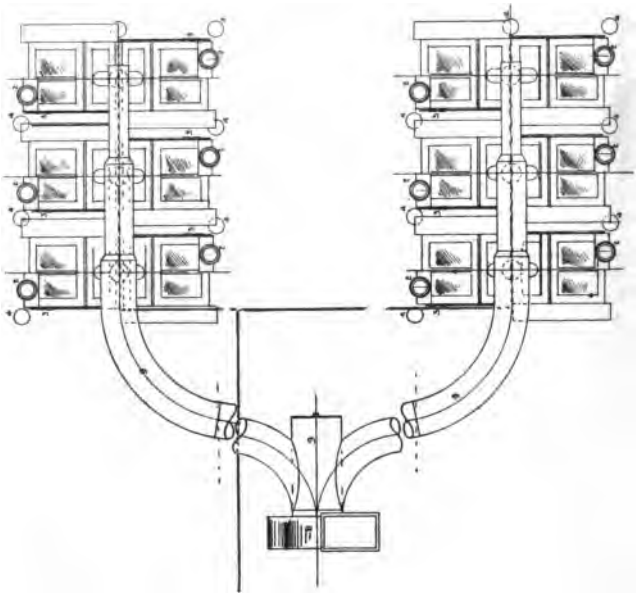

Fig. 99.—Plan of Figs. 96 and 97.

fully, and proposes to enlarge upon its arrangement and capacities for saving of labour, etc.

The whole of the work was carried out by Messrs. The Airostyle and Lithos, Ltd., and it must be admitted that the plants are so arranged as to admit of rapid handling of the work, and the subsequent stoving of the articles is just as conveniently provided for.

Two distinct plants are in use at the moment with a separate steel plate central draught fan and a water-cooled air compressor (the type of fan and air compressor employed is shown elsewhere in the book, see Figs 71 and 79).

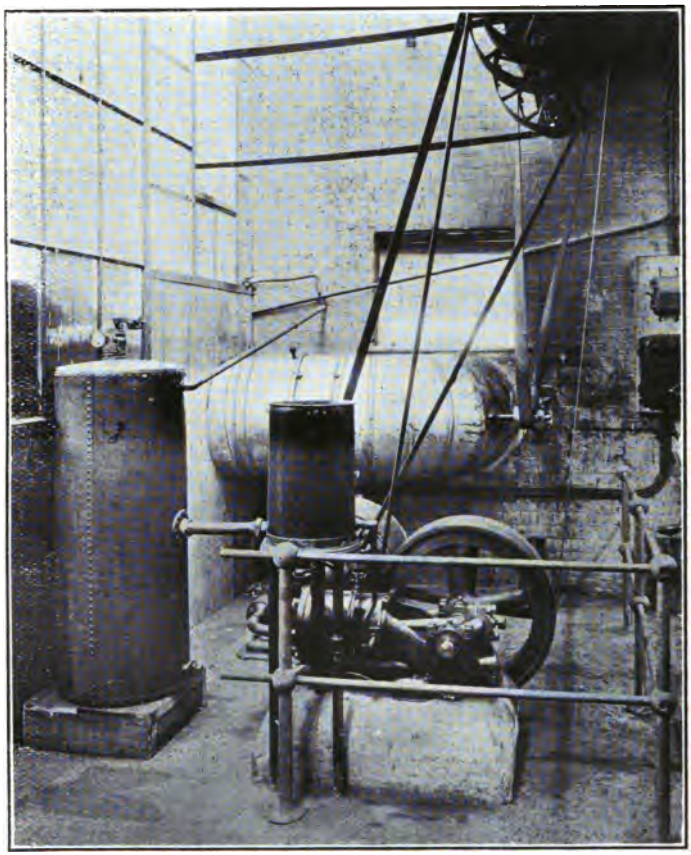

Fig. 100.—Airostyle Plant Power Unit, Compressor, Motor Fan etc., Installed for the Davis Gas Stove Co., Ltd., Luton.

On referring to the drawings Figs. 97, 98 and 99, showing respectively an elevation, end view and plan of one of the plants, it will be seen that the plant is divided up into two bays, each accommodating six operators, so that, in all, twenty-four operators are provided for in the two plants and were actually seen at work.

It will at once be noticed that ample space between the bays is provided, and this is most essential in order to give sufficient room for the racks which are wheeled into place behind each operator. These racks are readily seen in the photographs, Figs. 103 and 106, and can also be distinguished in Fig. 104.

The japanning shop in which the plants are installed is of large dimensions, 250 feet long by 48 feet wide, and is extremely light and airy, but, owing to the fact that the roof-lights are now painted over (by Government regulations), the shop at present appears to disadvantage, and the photographs consequently suffer.

The photographs, nevertheless, show very clearly what an immense amount of work can be daily handled, but, notwithstanding this, the writer was assured that there were still numbers of brush hands in the shop. This was primarily due to the fact that full arrangements for spraying are not yet completed (12 more operators are being provided for), and, secondly, to the fact that certain work needing a large amount of masking can be almost as readily brushed, and this class of work finds employment for brush hands. Messrs. Lucas, Ltd., admit that there is a wastage of japan, but maintain that a heavier and much more even coat is applied with a superior finish to brush work, and that there is an enormous gain in time of about 4 to 1 over brushing.

They state, also, that an indirect gain is obtained in the economical working of the stoves, for these are filled far more quickly, and, consequently, the daily output per stove is correspondingly increased.

A striking proof of the saving is their statement that if they had not the system of spraying at work, it would have meant 200 hands in the japanning department, whereas they now employed only 90, and a considerable number of these were engaged upon brush work, so that if only the whole of the work could have been handled with the spray, then the number of hands necessary would have been even less than 90.

The photographs, Figs. 105 to 107, need no description, and are self-explanatory to a large extent.

The type of instrument used, and the accessories, are described in detail elsewhere, as they are the standard practice adopted with all Airostyle plants.

The writer also had the privilege of inspecting another interesting Airostyle plant, installed at Messrs. G. Cabdy and Sons, Birmingham, where 7 or 8 operators are employed upon high-class celluloid enamel finishes upon buttons, medallions, cameos, electrical fittings, and last, but not least, numerous parts for munition work, such as cartridge clips for 18 or 24-pounders, etc.

The small articles are laid on a grid measuring about 11 inches by 9 inches, and while holding the grid the operator sprays over the whole of the article on the grid, and in the case of rounded faces of buttons, sprays these obliquely from all sides in turn, as well as over the tops of the buttons.

It may be mentioned that the greater part of the spraying paints and enamels are supplied by Messrs. Thornley & Knight, Ltd., of Birmingham.

The Birmingham Small Arms Co.

The cycle department of this well-known firm deals with an enormous amount of parts, and a new paint spraying department on an extensive scale is in course of construction at Redditch, and the method in use at the Birmingham works will be to a great extent followed. In both cases the "Midland" sprayer is used under a pressure of from 30 to 50 lbs.

The method is very thorough, and although comparitively expensive is well calculated to produce a finish which is (a) capable of withstanding hard wear and possible knocks and (b) absolutely rust-proof. The finish is elastic and very durable. It is produced by the following method. The steel or iron parts are first thoroughly washed in pure American turpentine in order to remove every trace of grease and dirt. In passing, it may be said that a suitable white spirit would probably answer as well and would effect a considerable saving, although it is possible that the pure turpentine leaves a certain residue behind it which is of advantage in forming a key to the subsequent coats. The parts are then stoved, when a coat of pure Baltic linseed oil is applied by means of brushes, and they are again stoved at 250° F. Then a coat of black japan, known in the works as "rubber solution," is sprayed on, and a third stoving is given in this case at 280° F. This is followed by two coats of khaki-coloured enamel sprayed on, which dries with a semi-gloss finish. The parts are stoved between each coat and after the final coat, so that they receive five stovings altogether.

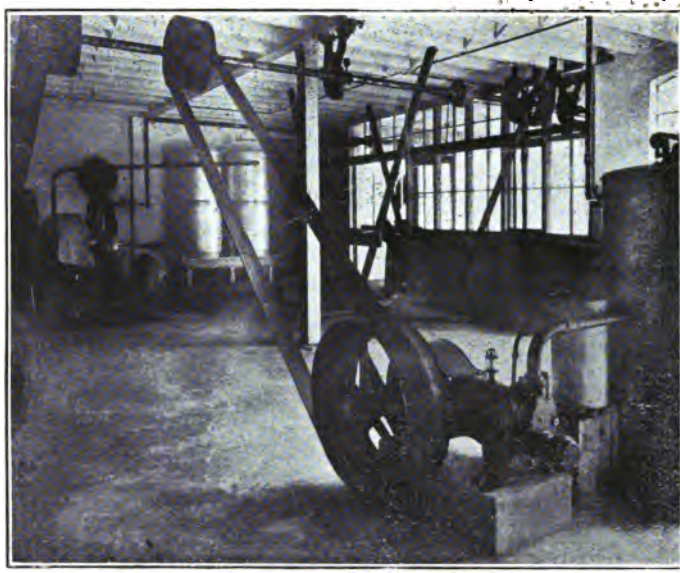

Fig. 101.—Compressor, etc., for Airostyle Plant for 16 Operators.

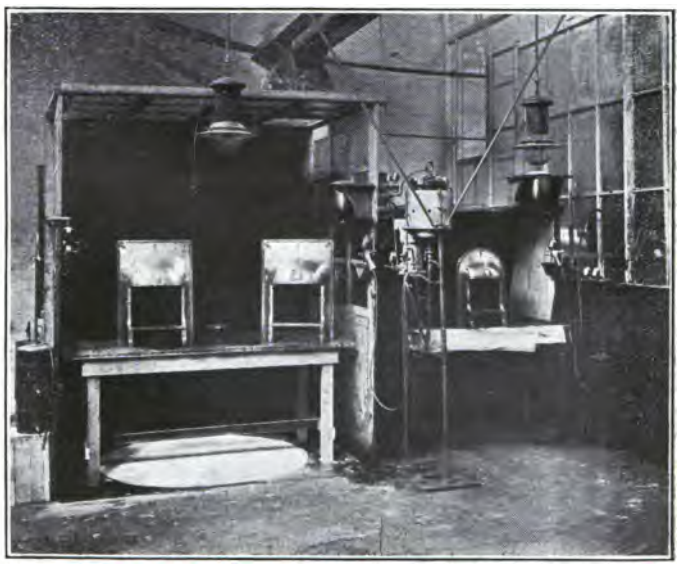

Fig. 102.—Airostyle Plant Installed for Gas Fire and Radiator Work for Messrs. The Davis Gas Stove Co., Ltd.

The ovens are of special construction and are described in detail elsewhere. The japans employed are supplied by Messrs. Arthur Holden and Co., Ltd., of Birmingham.

Samples of the work thus finished were submitted to the author, who carefully tested them. He found that the finish was all that could be desired. A piece of plate metal, for instance, was bent double without the finish being affected, thus showing very clearly the great elasticity of the coating—a most important and necessary quality in a finish for this class of work.

Messrs. Fletcher, Russell & Co., Ltd.

This well-known firm use spraying at their Warrington Works on an extensive scale. All parts of gas cookers, gas stoves, and ranges large and small, are sprayed by different sizes of the Airostyle sprayer. Stoving takes place in most cases, and the work of spraying effects a great saving, one man being able to do the work of at least three under the old brush system.

Some very beautiful effects are obtained in stoves intended for use in drawing, dining and reception rooms, by spraying various coloured semi-transparent lacquers over silver-bright iron or steel. Rich reds, browns, greens and blues in various shades are produced, and the bright surface beneath the lacquer gives a very pleasing and artistic effect. Stoving produces the necessary hardness of the lacquer, which may be regarded as being very durable.

Special Machines.

The Berkel and Parnall's Slicing Machine Co., Ltd., whose extensive works are at 6, Bow Common Lane, London, E., have had a plant for paint spraying in use for the last four years, and find it to be quite successful and a great saving of time over the old method of applying the paint by means of brushes, in addition to a superior finish being obtained. The sprayer in this case in the "Invincible," and the paint is sprayed on under pressure varying according to the nature of the work. The iron parts which go to make up the slicing machine are first primed and stoved and any imperfections stopped in the usual manner. They are then painted by means of compressed air and again stoved, after which they receive a further coat, which is also stoved. Various ornamentation in gold is then put on, mostly by the transfer process, although certain parts require lining by hand. The final coat of varnish

is given by means of brushes, it being found that this is the most economical way for this particular class of work. In this particular it will be observed that the method differs from that used in many other works where all the operations are done by spraying, including a final coat of varnish. The colour used for the paint is a bright red. There are two spraying cabinets with the usual exhaust, and turn-tables are employed for turning the parts round to receive the coat of paint. It may surprise some readers to learn the very large extent to which these slicing machines are used throughout the world for various purposes.

Gittings, Hills and Boothby, Limited.

The plant for spraying in use in these works is principally intended for experimental purposes in connection with the preparation of paints, varnishes and lacquers of various descriptions which tne firm manufacture. An up-to-date type of pistol is used, with a pressure not exceeding 30 lbs. to the inch. The work is done in a small closet with glass sides open at one side, and a small turn-table is employed upon which to place the article that is being sprayed. Some admirable results are obtained with the aid of gold lacquers. It is found that in certain varnishes the application of heat is an advantage, but as a rule the spraying is done cold. Among the articles which have been painted are motor cars and various smaller appliances.

The Kingsbury Manufacturing Co., Ltd.

A typical plant for finishing picture frames, furniture, fancy articles such as wood, cane and other ornamental baskets, is that of the Kingsbury Manufacturing Co., Ltd., 1, Markfield Rd., Broad Lane, Tottenham, N. This firm are the inventors of what is known as the "Inolite" system of gilding, which is described as an ideal process. Certainly the work produced is as near prefection as one would desire, the gilding being excellent in appearance, while it is guaranteed for five years to be free from discoloration or tarnishing. The process consists in applying by means of spraying, first, a coat of special enamel, which when dry is rubbed down with a solvent applied by a pad. Upon this is sprayed a coat of gold paint, and a final coat of colourless celluloid varnish is given which protects the gold from tarnishing. The process adopted is described in greater detail under the head of "Picture Frame Finishing" in this book.

Fig. 103.—View from one end of Messrs. Lucas, Ltd., Airostyle Plants, showing Fan and Compressor Drives.

The coloured celluloid enamels which are applied to fancy baskets, etc., have a very attractive metallic appearance, which is far superior to the ordinary crude bronzy effect. Another speciality of the firm is the finish of frames in special black, which gives a perfectly smooth finish which might be called "egg-shell gloss." It is quite artistic in appearance, eminently suitable for the particular purpose, and gives a durable frame at a comparatively small cost.

The firm estimate the saving of time by using the spraying as compared with that of employing a brush is as 5 is to 1. They point out that a little extra material is required, but this is not begrudged as it possesses advantages in an increased durability of the protective coating.

THE GAS LIGHT AND COKE CO.

Several of the works of this company, which deal with gas meters, are fitted with paint spraying installations. The branch at Laburnum Street, Kingsland Road, in charge of Mr. W. F. Fagan, may be taken as a type. Two Aerographs and three Airostyles are in use. The old meters that come to the works are examined, and if the paint is in fairly good condition the surface is rubbed down with pumice stone and water, but if it is much decayed the meters are placed in a hot bath containing a solution of lime and caustic soda, and allowed to remain in it a short time, when the paint becomes so soft as to be easily removable. The surface of new tinplate is cleaned down with spirit, when it is quite ready to receive the coat of paint. At these works many different makes of meters come in to be dealt with, hence various masks are necessary to protect those parts which it is not desired to spray. The pressure used here is rather more than usual, being 40 lbs. to the sq. inch. The time taken to paint a meter is very small, as can be understood when it is said that two men working on five-light meters can turn out 30 an hour. Before the spraying apparatus was put in, about a year ago, a man could paint with a brush about three meters in an hour, so that, with the present system, there is an immense saving. It is calculated that the whole of the original outlay of putting in the plant will be returned at the end of about a year.

The masks or shields having been placed in position, a cap is placed over each union and the paint is sprayed on. The meters are turned out at the rate of 900 to 1,500 a week of 48 hours. The spraying apparatus is provided with the

usual exhaust consisting of two 9-inch holes to each cabinet, with grating over. About 10 per cent. more paint is allowed than that used when it is applied by hand, but the greater part of this goes on the surface, and the coat of paint as a protector is distinctly improved. The exhaust is carried up to the roof, but the actual loss of paint is very small.

Fig. 108 shows a general view, and a large central draught steel plate fan is employed to exhaust the hoods, and to drive this and the compressor a gas engine is employed. The compressor is of the type illustrated in Fig. 71, page 115, and can just be discerned behind the gas engine.

Fig. 109 shows a gas meter in position, with the necessary masks fixed, and Fig. 110 shows the operator about to spray-paint same. This plant has been in daily operation for more than two years.

The Gas Meter Co., Limited.

The installation of a spraying plant at the works of this firm, which are at 238, Kingsland Road, have been in operation for rather less than a year, but has proved quite satisfactory. Various types of gas meters are sprayed with one coat of Torbay paint, which is an iron oxide paint of high quality, and the one coat possesses amply sufficient quality to give a good covering. Prior to painting the surface of the tinned plate which is used for gas meters, it is cleaned down with a piece of waste dipped in spirit. Masks are used to fit over name plates, etc., and the spraying is done in the usual cabinet, with an exhaust. A three or four-light meter takes about two minutes to do, and the larger sizes, of course, longer in proportion. All sizes up to and including 500-light meters are sprayed, but those larger, up to 1,000 lights, are a little too big to handle. The greater part of the meters are done in deep red oxide iron colour, but three other colours are used in addition, as may be required. The meter to be sprayed is placed on a turn-table which bears on a sharp steel point and has on its upper portion spikes or ridges, to hold the meter in position. The Aerograph spray is employed in this case.

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Fig. 104.—General View of Airostyle Plants at Messrs. Lucas' Ltd.

Fig. 105.—J. Lucas, Ltd., Airostyle Plants, showing the Ample Space between Hoods.

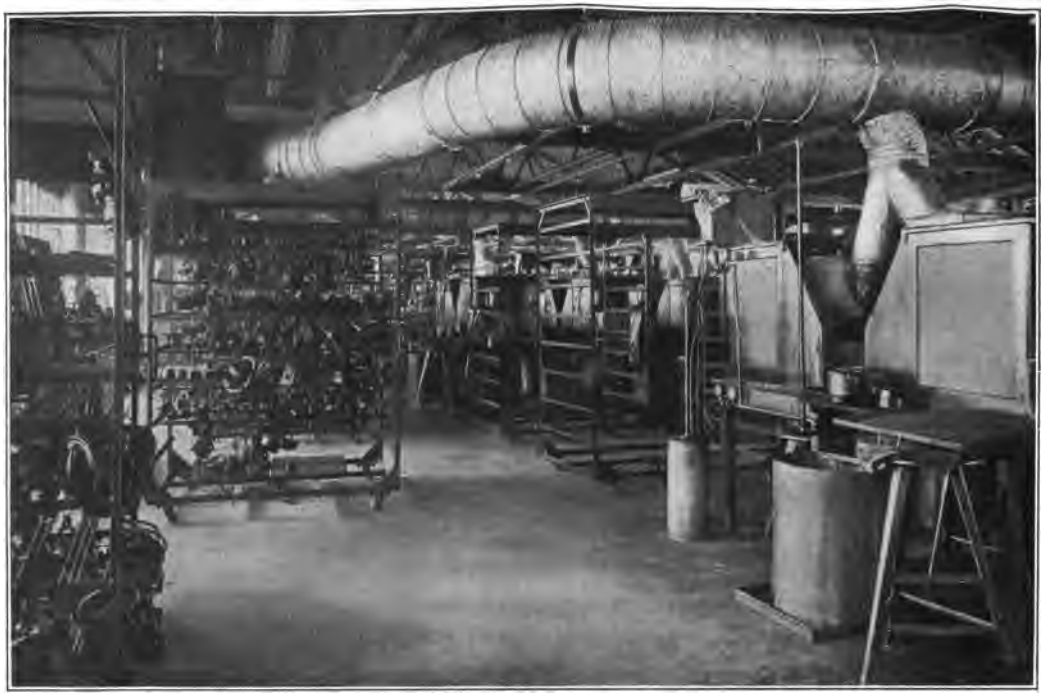

Fig. 106.—J. Lucas, Ltd., Airostyle Plants, showing the Method of Employing Racks to Greater Advantage, and also giving a Clearer Idea of the Large Fan Employed

CHAPTER X.

PAINTS, LACQUERS, VARNISHES, ETC. USED IN SPRAYING.

Under the head of "Paints used for Dipping" some information has been given in respect to the paints suitable for that purpose. Some, but not all, paints are suitable for both dipping and spraying, the exceptions being the heavier or more viscous compounds, which are not suitable for painting by immersion because they are too thick. Tar, enamel, and the heavier varnishes may be given as examples, although they may be successfully applied by the spraying process.

Sometimes in dealing with the heavier compounds the application of heat is an advantage. This may be applied to either the paint or the compressed air or to both in order to increase the fluidity of the compound. It is important when heat is thus applied that the temperature of the room in which the spraying is done should be raised correspondingly, so that the heavier paints, enamel, etc., do not congeal by being directed against a cold surface. Under most circumstances it is unnecessary to apply heat, provided that the spraying room is kept at a temperature of not less than 60° F. both in summer and winter.

As already intimated, the preparation of paints, lacquers and varnishes for both dipping and spraying necessitates a close study of the special requirements. In the case of paint the particles of pigment must be very finely divided as coarse material would tend to choke up the spraying apparatus, or if even they did not actually have that result they would require a greater pressure of air and thus add to the cost of working. Zinc oxide, the various grades of black and most bright reds, are examples of finely ground pigments which are well suited for spraying.

In buying materials for this purpose it is well to purchase of those firms who have made a special study of the subject.

The following is a list of a few such firms, all well known to the writer, and although it by no means exhausts the list yet anyone desiring to buy materials may very safely leave themselves in their hands.

Messrs. Docker, Bros., Ltd., Birmingham; Gittings, Hills and Boothby, Ltd., Tower Varnish Works, Long Acre, Birmingham; Goodlass, Wall and Co., Ltd., Seal Street, Liverpool; A. Holden and Sons, Ltd., Bradford Street, Birmingham; Indestructible Paint Co., Ltd., King's House, King Street, London, E.C.; Lewis Berger and Sons, Ltd., Homerton, London, N.; Llewellyn Rylands, Ltd., Balsall Heath Works, Birmingham; Mander Bros., Wolverhampton; Postans and Morley Brothers, Ltd, 19, Lionel Street, Birmingham; The Frederick Crane Chemical Co., Birmingham; Thornley and Knight, Birmingham; Wilkinson, Heywood and Clark, Ltd., Caledonian Works, Poplar, E.; Pinchin, Johnson and Co., Ltd., Bevis Marks, London.

The following are American firms:—

The Moller and Schumann Co., Chicago, Ill.; John Lucas and Co., Inc, Gibbsboro', N.J.; The Chicago White Lead and Oil Co., Chicago, Ill.; John W. Masury and Son, New York, N.Y.; The Glidden Varnish Company, Cleveland, O.; The Sherwin-Williams Co., Cleveland, O.;

STOVING ENAMELS.

We now reach these important enamels, and extract the following from the foreword of the little book above mentioned. Messrs. Wilkinson, Heywood and Clark claim to be the first successful makers of stoving blacks, which was in the days before the introduction of bicycles. Though originally introduced for cycle work, stoving enamel produces a most successful finish for all kinds of materials. In the United States of America such enamels are used in great quantities for finishing standardised motor bodies. These black enamels have gained a very high name for themselves, as properly baked they are extraordinarily hard, brilliant and tough, and when applied over such material as tin sheets are flexible enough to withstand being bent double without showing signs of cracking. An important feature are the coloured enamels made by the same firm, which run through a whole series of yellows, reds, browns,

greens and blues, and are hard, durable and tough, and can be stoved without changing colour. We extract the following notes on the "Application of Stoving Enamels," and fully endorse the recommendations offered:—

1. All work should be perfectly free from dirt, grease or oil, before application of enamel.

2. Every trace of moisture should be removed before enamelling. This can be effected by stoving the work, previous to enamelling, at a light heat. Moisture on work will cause enamel to blister and burn.

3. Always when using brushing or dipping enamels, allow the enamel to set slightly (i.e., after the surplus paint has dried off) before putting in the baking oven. This will prevent uneven stoving and eliminate "fat edges," as far as possible.

4. Oven heat should be increased gradually. Never place enamelled work into a hot oven at once, but raise the heat by degrees, until the full temperature is obtained.

5. Most of our enamels are sent out slightly thick; should an easier working material be desired, in the case of colours or blacks, add kerosene gradually until the required consistency is obtained. Coloured enamel should always be stirred before use, to prevent the pigment settling and the light medium rising. If this is not done, the appearance of the work will lack body and appear dull and lifeless. This applies especially to dipping enamels. To render white stoving enamel thinner, add pure turpentine only, stirring well, until a uniform consistency is obtained.

6. It is quite possible to over-bake enamels and spoil the colours, and likewise under-baked enamels will not be tough enough to withstand hard wear. Particular attention should be paid to the directions on the package labels, as the various pigments require different temperatures.

7. Stoving enamels, if left in an opened can, tend to thicken considerably. For this reason, keep the can closed when not actually using the enamel.

For thinning purposes we recommend kerosene. Sp. gr. 810 at 60° F.

8. Ovens should be properly ventilated to allow the proper oxidation necessary in baking.

ENAMELS.

It has already been pointed out in these pages that the success of painting by dipping, spraying, "flowing on," in fact, all other mechanical means, depends upon the

exact properties of the materials used. The same is true with enamels, which are made from a large variety of formulæ so as to dry slowly or quickly in the air, or when subjected to heat in a stove. The author feels he cannot do better than take as a guide to the properties of enamels in general the extremely useful handbook published by Wilkinson, Heywood and Clark, under the head of "Enamels for every Purpose." This book gives practically all the information concerning enamels likely to be required by the average user. The products are divided up under different heads, for example, one page is headed "Heat Resisting and Slow Drying Enamels." These dry fit to handle in 16 hours, and dry bone hard in 24 hours. They are made to withstand heat up to 212° F., and for this reason are suitable for enamelling iron baths, radiators, etc., particularly so as to effectively resist hot water without softening or peeling. They are made in a number of beautiful colours. A somewhat similar series of enamels is made which dry quicker, viz., in 8 hours fit to handle and quite hard in 12 hours. They are useful for touching up radiators, stoves, steam pipes, etc., and are made in white and a dozen or more colours. The next series which demands our attention are "Dipping Air Drying Enamels." They dry in 8 hours and are quite hard in 12 hours. They are claimed to produce a finish equal to that obtained by a quick air drying brushing enamel with the labour of brushing eliminated. For a finish done by immersing the article to be painted these are capital enamels, but they require to be used with a stirrer of some sort in the tank.

Hints on Stoving or Baking.

The degree of heat to which an article is subjected after being painted or japanned will obviously depend upon the kind of coating used. It is safe to assert as a general rule that the heat applied must not be higher than the particular paint or enamel is made to withstand, for, if this be exceeded, it will inevitably result in a loss of elasticity of the protecting film and, hence, its durability.

The following hints are taken from a very useful little pamphlet issued by the Moller & Schumann Co., of Chicago, Ill. The degrees of temperature given refer to their products, and would doubtless have to be modified in some cases, according to the nature of the paint being dealt with. They will, however, form a very useful guide.

Fig. 107.—J. Lucas, Ltd., Airostyle Plants, showing the Two Bays of One Complete Unit.

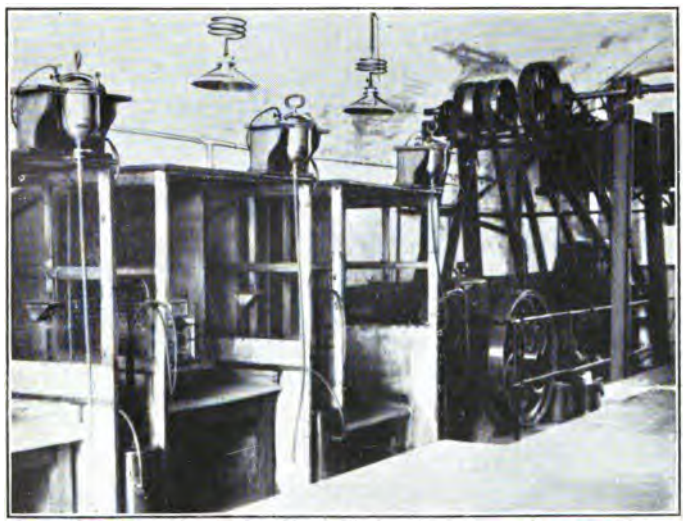

Fig. 108.—Airostyle Plant Installed for Messrs. The Gas Light and Coke Co., Ltd. General View.

Black Japan Finishes.

One or more coats rubbing finish japan, reduced as thin as possible and still cover well.

Bake each coat at 250° to 350° for 3 to 4 hours. Sandpaper each coat lightly.

One or more coats finishing black japan reduced to brushing consistency (not too thin).

Bake each coat at 300° to 350° for 3 to 4 hours. Sandpaper each coat lightly. Rub the last coat with pumice. Apply transfer and striping to last coat of japan.

Bake these at 150° for 1 to 2 hours.

One or more coats finishing copal brushed as it comes from the can. This protects the transfer and striping and increases the depth of the finish.

Bake each coat at 175° for 2 to 3 hours. Rub each coat and polish the last coat.

If finishing copal is omitted, leave the last coat of japan in gloss, or rub and polish as preferred.

Steel Furniture Enamels.

One or more coats of first coat enamel, reduced as thin as possible and still cover well. When brushed on, use steel preservative for back and underside of metal, one coat only, baked at same time as first coat of first coat enamel.

Bake each coat at 250° for 3 hours. Sandpaper each coat lightly. One or more coats of finishing enamel.

Bake each coat at 250° for 3 hours. Sandpaper all but the last coat. Rub the last coat with pumice.

Enamels when rubbed have a different colour than the surface colour; this must be taken into account in finishing.

Transfer and striping, if any, should be put over last coat of finishing enamel. Bake at 150° for 1 to 2 hours. One or more coats of finishing copal.

Bake each coat at 175° for 2 to 3 hours. Rub each coat, and polish the last coat.

If finishing copal is omitted, leave the last coat of enamel in gloss, or rub and polish as preferred.

The same enamel will bake to different shades at different heats and varied lengths of time, so care must be observed to get uniform results.

Imitation Wood Effects.

One or more coats of ground colour; back of metal one coat steel preservative, both reduced as thin as possible, and

still cover well. If the steel preservative is used by dipping, only one coat of ground colour is generally used.

Bake each coat at 250° for 3 hours. Sandpaper each coat of ground colour. One coat of graining colour, reduced with turpentine brushed on, and grained by hand, or with tools as in general graining. This may be done by machine or as transfer work.

Bake the graining colour at 200° for 2 to 3 hours. Sandpaper lightly.

Put on transfer and striping, if any, over last coat of finishing enamel.

Bake at 150° for 1 to 2 hours. One or more coats of finishing copal.

Bake each coat at 175° for 2 to 3 hours. Rub each coat. Rub and polish the last coat.

In this work, at least one coat of finishing copal is necessary to protect the graining colour.

White Work—Bedsteads, Etc.

White work cannot be finished with one coat, because no white pigment has sufficient covering power.

Two or more coats of first coat white enamel.

Bake each coat at 120° to 150° for 3 to 4 hours. Sandpaper each coat lightly.

Two or more coats of finishing white enamel.

Bake each coat at 120° to 150° for 3 to 4 hours. Sandpaper each coat lightly except the last coat.

For gloss finish, leave last coat as it is; for eggshell finish, rub the last coat.

Finishing copal is rarely used over whites because of colour.

Transparent Colour Varnishes.

These varnishes are used over smooth, clean, bright metal. As the metal shows through the varnish, no primer or filler can be used.

One coat only is applied, usually by brushing or by a coating machine; however, it may be dipped or sprayed.

Bake at 225° for 3 hours.

The more these varnishes are reduced, the lighter the colour becomes.

Fig. 109.—Airostyle Plant Installed for the Gas Light and Coke Co., Ltd., showing Hood in Greater Detail and a Meter with Masks Affixed.

Safe Baking Heats of Pigment Colours.

All colours are more or less affected by heat. They lose their brilliancy, become very much darker and sometimes turn black when baked at too high a heat.

Prolonged heat (not too high) kills the elasticity of the enamel. It does not affect the colour.

To assure brilliancy of the colour, the following highest heats can be used with safety.

White	160°	4 hours.
Pale Blue	175°	2-3 ,,
Pale Gray	,,	,, ,,
Pale Green	,,	,, ,,
Pale Yellow	,,	,, ,,
Gray	200° - 225°	4-3 hours
Bright Red	,, ,,	,, ,,
Green	,, ,,	,, ,,
Yellow	,, ,,	,, ,,
Dark Blue	,, ,,	,, ,,
Olive Green	240° - 275°	4-3 hours
Maroon	,, ,,	,, ,,
Brown	,, ,,	,, ,,
Black - any heat up to 600°		

Comments on the Above.

A well-known English firm, commenting on the above says :—

"Generally speaking, the information given therein is quite correct, though it should be remembered that instruction as to stoving temperatures which might be quite correct with one maker's materials, might be quite wrong with another's.

"We notice they recommend that all black japan finishes should be stoved at from 250 to 350 degrees. This is the general practice in England, but it also happens that some firms cannot use these high temperatures or some goods will not stand it, and black japans have to be supplied which can be stoved at temperatures of about 180 or 200 degrees Fahr. Such qualities cost rather more to produce.

"We also notice it is recommended that finishing varnish should be stoved at 175 degrees Fahr. Personally, we cannot make any clear finishing varnishes which will stand this temperature without discoloration, and even if used over

black japan, they would discolour the lining or the striping thereon.

"The temperatures recommended for coloured enamels are also higher than we find satisfactory, and the statement made that the same enamel will bake to different shades at different heats, and that therefore a uniform temperature is necessary to obtain uniform results, seems to confirm our view. In practice we think that uniform results can only be obtained by using a lower temperature. If a workman has to watch the thermometer in a stove to make sure that his enamels will always discolour to the same degree, you can rely upon it that in practice accidents would soon happen."

Dipping and Spraying Paints Compared.

From the above it can readily be seen that it is necessary to exercise considerable care in the selection of paints for both of these processes. The following opinions on this important subject are given by the firms named.

Messrs. John Lucas and Co., Inc., Gibbsboro', N.J., U.S.A., say:—

"It is our experience that a paint which is suitable for dipping purposes can also be manipulated for spraying. A paint to be suitable for spraying depends largely on two factors, namely:—Gravity, or weight per gallon, and consistency, or fluidity. A paint made from pigments which are heavy gravity will not produce good results for spraying, just as it will not prove satisfactory for dipping, because of the tendency for the pigment to settle out. In the case of spraying such paints produce an uneven finish. A paint such as is ordinarily used for dipping contains sufficient light gravity pigments to make possible reduction with the proper vehicles (depending on the desired finish) so that by spraying a satisfactory coating can be produced so far as finish is concerned. We are not certain whether a coating produced by spraying will wear as long as a coating which is applied either by dipping or by brushing."

The Chicago White Lead and Oil Co., Chicago, Ill., say:—

"There is no very intricate or specific formula for this class of material. The following rule we think will prove a safe one to follow:—

"Always select a pigment which will stay in suspension, and also hold with it the extenders such as very fine silica. The addition of a very fine silica to all dipping or spraying

paints will add materially to the flowing off and levelling of the finish. The pigments should be ground very fine in varnish, the grade of varnish depending upon the quality of the material to be produced, and reduced to working consistency with varnish and turpentine, or naphtha.

"Linseed oil should be avoided in the preparation of dipping paints, as the tendency of linseed oil to wrinkle is very objectionable. Chemically pure colours, such as green, yellow, para toners, etc., are best adapted as colour bases.

"The above constitute the principles upon which we have produced extremely satisfactory paints for the purpose named. These, coupled with expert workmen, will produce excellent results. The average formula for paints can only be considered as a general guide; the successful blending, tinting, etc., must be perfected by careful and sometimes extended experiments.

"The difference between a dipping paint and spray paint is in the consistency. A spray paint must naturally be made thinner, and consequently only the most dense of colours should be used and a smaller amount of inert pigment as an extender, or leveller. A few experiments with a spraying apparatus (of which some inexpensive hand sprayers can be obtained) will quickly guide the paint man as to proper consistencies to produce best results."

Messrs. John W. Masury and Son, of New York:—"It is practically impossible to give full particulars regarding varnishes and enamels for spraying and dipping, for the reason there are so many different kinds and they vary so much owing to the different character of work that a description of them is out of the question. In a general way it may be said that dipping coatings must be quick setting, so as to avoid runs and sags; it must flow out to a smooth, even surface. The drying quality must depend upon the kind of work being done, character of surface, subsequent exposure, and whether the coating is to be baked or air dried. Dipping varnish and enamels are made for many classes of work, such as all kinds of small iron castings and sheet metal work, as well as wood work, vehicle wheels, parts of automobiles, and in some cases wagon bodies and automobile bodies, these last only in one or two shops. These goods include cheap black baking japans, coloured enamels of various kinds and clear varnishes.

"In regard to spraying enamels, the 'spray brush' is gradually coming into use. These goods must be made to suit the character of the work; the body or viscosity of the material, the pressure used in the spray and character of the surface to be coated, must all be taken into consideration and properly graduated to insure suitable finish.

"In both dipping and spraying work one, two and three coats are frequently used, sometimes the under coats are only dipped or sprayed, while the finishing coat is applied with brush.

"The equipment for dipping will vary also with the article to be dipped; it includes dipping tanks of suitable size and snape, racks for hanging articles dipped, with troughs or trays to collect surplus material. In dipping it is necessary to wipe off with brush the surplus which gathers on lower edge of the article.

"Equipment for spraying requires besides the spraying machine a pressure tank with suitable cocks to regulate pressure, which will vary from thirty to fifty pounds, a suitable hood provided with fan to draw off any fine spray away from the workman, proper racks for taking care of the finished work. Work done with spray does not require any wiping up."

Fig. 110.—Airostyle Plant Installed for the Gas Light and Coke Co., Ltd. Operator at Work on Gas Meters.

CHAPTER XI.

SPRAYING VERSUS BRUSHING.

It will be convenient now to consider the length of time involved in spraying, as compared with that involved when painters' brushes are used.

In dealing with this question, it should be pointed out that while some little gain is apparent in the actual time occupied in handling the article, which is mostly done on turn-tables when spraying, yet no note is taken here of the difference in handling, but only the time occupied in covering the article with paint, japan, etc.

We will take, by way of example, a modern gas fire. Very few of these are now brushed. It is the consensus of opinion that a gas fire takes 10 minutes to brush.

To spray one, with a superior finish, takes 30 to 45 seconds, and even where some difficulty is experienced in handling, or where it is the practice to have the firebricks in place beforehand, so necessitating the use of a mask, in no case is a greater time than 1½ to 2 minutes taken. A cycle lamp, small size, takes fully 2 minutes to brush properly. To spray the same lamp takes 10 seconds. A gas meter, 5 or 10 light size, takes 7 minutes to brush. To spray one takes 1½ minutes, allowing for the time occupied in fixing and removing the somewhat elaborate mask employed for covering the indicator glass, badges, name-plate, etc.

A motor headlight takes nearly 20 minutes to brush properly, whereas to spray one takes but 1½ minutes at the outside.

To brush a cycle frame takes 10 minutes or so (brushing is still done for coloured work).

To spray either in japan or colours takes 1 to 1½ minutes, and when it is considered that a heavier coat can be applied than is the case when brushing or dipping, it will be admitted that such a result compares favourably even with dipping.

A 2-seater motor body takes from 25 to 45 minutes to brush properly.

To spray the same body takes only 6 to 8 minutes, and when it is noted that a fraction of the rubbing down is necessary in the case of the sprayed result, as against the brushed body, it will be granted that an enormous gain is to be effected.

Where two or more colours are employed, it is difficult to make comparisons as readily, but, generally speaking, it is the practice to employ two instruments per operator where the colours are applied one immediately after the other, as is the case with many electrical parts, and in this case a gain of 4 or 6 to 1 is shown over brushed work.

In some cases it has been found an advantage to spray one coat and to brush the other, especially where some difficulty is experienced in masking, and, in such cases, the only way to arrive at the most satisfactory method is by actual test.

In other cases, such as bronzing, with a celluloid medium, it is absolutely impracticable to apply these bronzes, save with the spray, unless the old method of varnishing and afterwards dusting on the bronze is adopted; but, of course, against spraying, such an obsolete method as the latter has absolutely no chance when speed is considered.

Iron piano frame manufacturers have almost universally adopted the system of spraying bronze on the frames. Where the old-fashioned method is still in use, it is usually because the quantity of frames to be dealt with is hardly large enough to justify the outlay required in the purchase of a plant.

Another advantage should be mentioned. The special celluloid japans now largely used for application by means of compressed air obviate the necessity of a considerable amount of rubbing down and papering, etc., which cannot be dispensed with when the liquid is applied by means of a brush.

For the purpose of comparison, it may be said that these japans may be sprayed upon such articles as buttons, medallions, electrical and bedstead fittings, and also on wood brush-handles and furniture, large and small, with a gain of 5 to 1 over brushing.

Objections Sometimes Urged Against Spraying.

Having explained the advantages of the spraying system, we may now consider the objections which are occasionally raised against it.

One of the arguments most frequently used is that the effect thereby obtained must be less durable than is the case of the brushed effect.

Why such a theory should be advanced is a little obscure, for, theoretically, it is possible to apply, with a properly fitted plant, a far more even coat than is the case when brushing, and seeing that such paint is applied with the idea of protecting the article against rust, or corrosion, or of improving the appearance, the argument is for rather than against spraying.

However, to come to the practical side, the evidence is all in favour of spraying, for it has been proved by many exhaustive tests by independent persons, that, with the same material treated in the same manner, *i.e.*, either air dried or stoved after spraying or brushing, there is no difference in the durability of the japan or paint, and that the sprayed result has this advantage, that some little gain in time is effected in the period occupied in drying or stoving of the paint.

Another objection is sometimes raised to the application of paint by means of the spray to rough and uneven surfaces. The argument here is that it is impossible to make the paint adhere to the surface, save with a good stiff brush.

Such arguments ignore the pressure at which the paint is applied, which is usually between 30 and 45 lbs. per square inch, and are mainly based on unfortunate experiences with early types of whitewashing machines, which have already been pointed out to be entirely unsuited to painting problems.

Again here, it may be positively stated that in no case has it been found that a less durable finish is obtained with the spray. As a fact, an advantage is to be recorded in that on rough surfaces the gain in time is enormous, for such surfaces may be spray-painted as rapidly as the smoothest surface obtainable, whereas the labour of brushing such rough surfaces is very considerable.

Still another objection which may be mentioned is the slightly mottled appearance which the sprayed surface sometimes shows when finished—if such can be objected to seriously.

This objection may be met by the statement that such a mottled effect is only apparent when the paint has not been specially prepared for spraying, and is mainly due to the fact that mediums used dry rather too rapidly and do

not allow the paint (which is, of course, applied in minute spots) to flow out.

The remedy is naturally to re-model the paint should the mottled appearance be objected to, but most certainly such an effect, if not pronounced, is not any worse than brush marks, which are always noticeable unless rubbing down has been done.

In passing, it may be stated that most of the large paint and varnish manufacturers have experimental plants for producing spraying materials, and they are naturally well able to answer any queries which may be likely to arise and which may not be adequately dealt with here.

Many firms who consider the question of adopting a spraying plant seem to have the idea that while the principle is admirable for many trades, yet it cannot be successfully employed in their particular case, and one frequently finds the manufacturer of small goods wondering why his neighbour opposite, who makes, we will say, motor bodies, does not instal a plant, although, of course, in his own case the question is impossible. Most probably, at the same time the said neighbour has precisely similar thoughts, save that he considers the only proper use for a plant is in small work.

Occasionally one hears the opinion advanced that primers or fillers cannot be applied with a sprayer, or, if so applied, it is at a risk that they will either crack or peel off afterwards.

This objection may just as readily be advanced in the case of brushing. If trouble of this kind occurs, it is not due to the method of spraying, or brushing, so much as to the way in which the paint has been used. This statement sounds paradoxical, yet it will be understood by practical men. For instance, it is obvious that motor bodies, par exemple, must be dealt with by the expert coach-painter as far as the methods, number of coats, etc., to be employed are concerned, even though the work may be carried out by unskilled labour, and naturally whether brushed or sprayed, motor bodies cannot be well done by novices.

To summarise, it may be confidently stated that whatever difficulties there may be in the application of paints, enamels, varnishes, lacquers, etc., by means of brushes in the ordinary way, these are certainly never accentuated but are in most cases considerably lessened by the use of an adequate spraying plant.

Spraying and Dipping Compared.

In considering those articles which may be dealt with either by dipping or spraying, the manufacturer has first to take into account the number of coats necessary.

If, for instance, to produce the correct finish on a cycle frame, when dipping, needs three coats, and assuming that the same effect may be obtained in two when spraying (and this is frequently the case), then spraying must be considered to rank favourably with dipping, and if allowance be made for the time taken to drain, and the room occupied with an elaborate dipping plant, then again spraying scores, for a cycle frame can be sprayed in 1 to 1½ minutes, or, say, 40 to 50 frames per hour, which is very little, if any, less than can be comfortably dealt with by dipping, and, of course, no time is lost in draining.

If, on the other hand, gas is so cheap as to be of little consequence whether two or three stovings are necessary, and if some of the work can be done with two coats, then the saving effected when spraying would not be sufficient to warrant the outlay necessary for a modern compressed air plant, *unless* a fair proportion of coloured work, not easily dipped, was required to be dealt with. In this latter case, a spraying plant ought to receive very serious consideration.

To take another case. Some gas fires may be dipped, but, owing to their weight and to the fact that they are seldom entirely free from grit or dust, they are not a satisfactory type for dipping, and we venture to state that all the leading gas engineers have dropped the question of dipping such work in favour of spraying, although in some cases, for gas cookers, the accessories, such as burners, bars, racks etc., are dipped.

Such accessories are as readily sprayed, but as only one coat is applied, naturally no saving is shown over dipping.

Other goods sprayed or dipped are steel implements, hoes, spades, shovels, axes, picks, etc., and in some cases it is an advantage to dip where the same colour, black, red, etc., is needed, say, half-way up the spade or hoe, but otherwise spraying should be adopted; and, of course, in many cases where two colours are employed it is out of the question to dip, the only alternative being to spray or brush—spray for preference on account of the enormous saving of time over brushing.

Where very small articles are dealt with in bulk and can be so handled that trays may be used, then these are undoubtedly better dipped; but if various colours are needed

it is better to still use the trays, but to spray them, as the speed is approximately the same as when dipping.

A tray full of camera parts is sprayed almost instantaneously and with a far better finish than if dipped.

To sum up the various arguments advanced on this subject, we may come to the following conclusion.

As already intimated, the saving effected by painting by immersion or by spraying as compared with brushing is very large indeed, provided that a properly equipped plant is employed, and the paint or enamel is exactly fitted for the purpose. The question must often arise as to whether dipping or spraying is the best and cheapest to employ. The answer is that everything will depend upon the nature of the article that is to be painted. Speaking generally, painting by immersion possesses many advantages, because the actual work of applying the paint is done in a few minutes and every part of the article is covered with paint at one time. In reaping machinery, iron treads of staircases and many other parts of the kind in which there are a large number of small parts or depressions, paint dipping cannot be improved upon; on the other hand, spraying possesses distinct advantages in dealing with many classes of goods which are of such a shape or character that if the paint were applied by dipping some accumulation in parts would inevitably occur.

A decision on the subject can only be arrived at after a very careful study in comparison of the two methods. It will frequently be found that, on the whole, the most economical plan to pursue is to dip the first and subsequent coats, excepting the last, and to spray this on, particularly when it consists of varnish or a viscous liquid. It is in this particular that one can draw a wide distinction between the two methods. In dipping, the paint must not be very thick, and, as previously stated, in designing a paint for the purpose the greatest effort is made to produce one which gives a happy medium between excessive thickness and the reverse, too thin a coat. Just as soon as the peculiarities of the article to be painted necessitate the use of all thick paint or enamel it must be considered that dipping is not suitable, but that spraying is. The latter may be employed successfully with any liquid up to the thickness of tar.

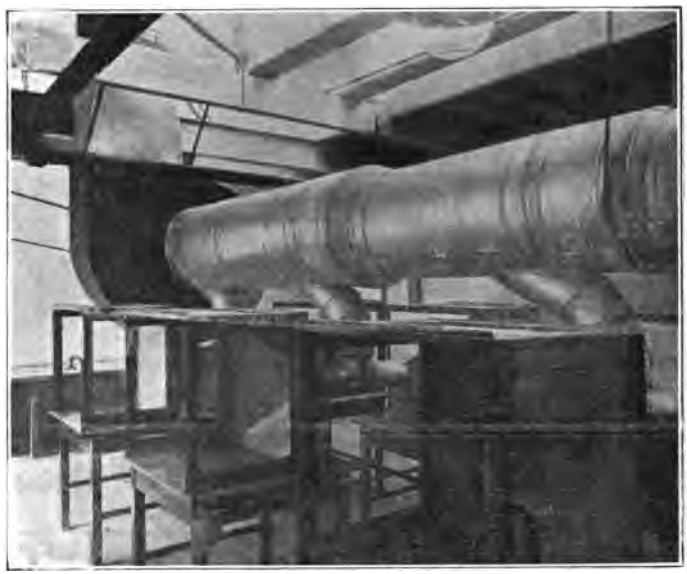

Fig. 111.—Airostyle Plant showing Ventilator and Portion of Hoods for 4 or 6 Hoods Providing for Subsequent Enlargement.

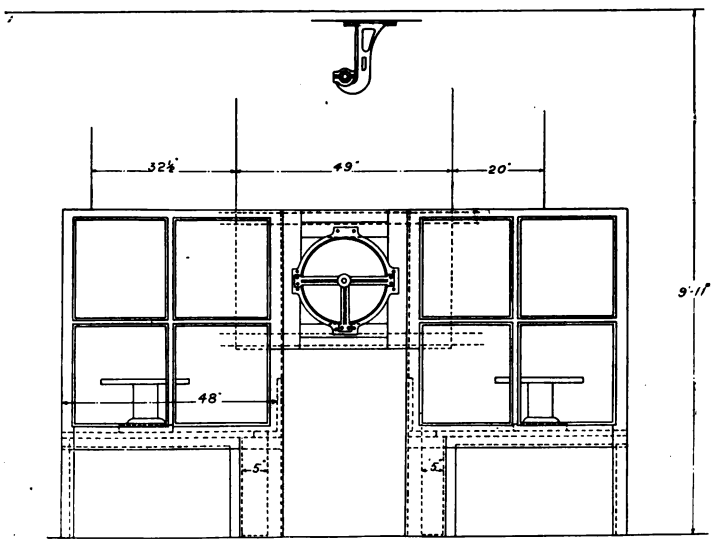

Fig. 112.—Elevation of Spraying Plant.

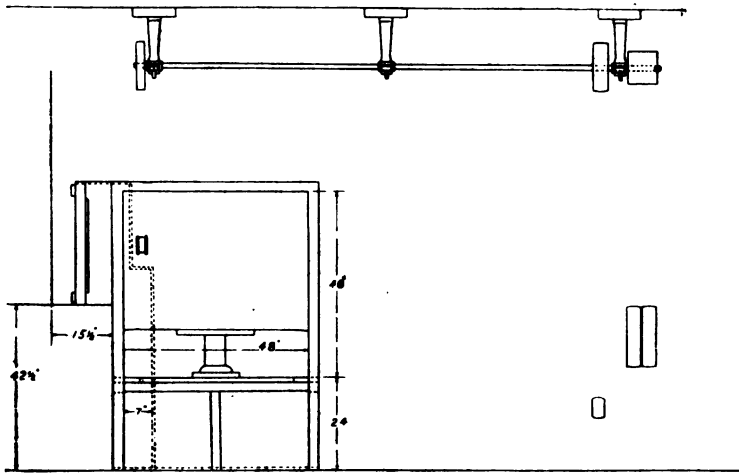

Fig. 113.—Elevation of Spraying Plant.

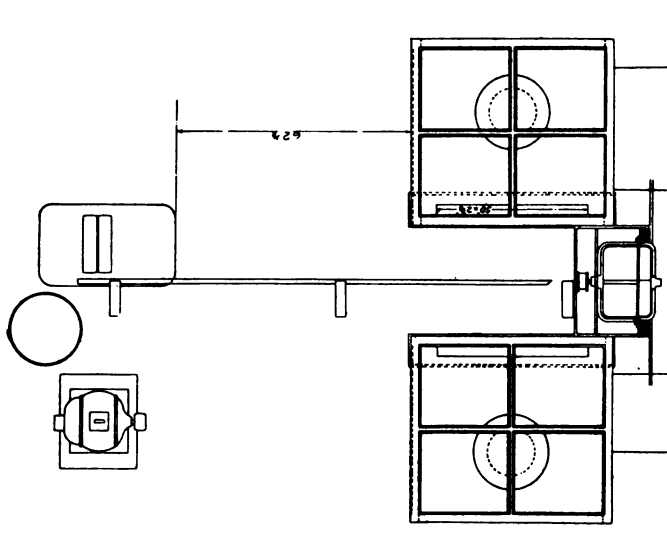

Fig 114.—Plan of Figs. 111 and 112.

CHAPTER XII.

THE ARTISTIC APPLICATION OF PAINT SPRAYING.

Some of the smaller and more delicate types of spraying apparatus are largely employed for such purposes as the following:—Black and white and water-colour drawing, photograph finishing, preparing pictures for process blocks, Christmas cards, window tickets, embossed cards and small stencil and shaded work on fabrics, wood, glass, metal, leather, etc., lithographic work, picture painting in oils, decoration of pottery and stencil and shaded work of all kinds. They are also employed for producing very charming effects in wallpaper. The writer has seen most creditable examples of work done in this way on menu cards, lamp shades, and even stencilled ornaments on men's ties.

A few examples of this class of work are given in the accompanying illustrations.

It may be pointed out that when decorative work is required on metal work or engineering appliances, it can in most cases be done by spraying without much difficulty, aided in some cases by stencils specially cut for the purpose. Thus the outline of a trade mark, a monogram or a coat-of-arms, or heraldic device can be easily sprayed and be then finished by hand.

Again, the lining on a motor or carriage can, if care is taken, be done by the same means, although it must be said that the result is never quite equal to that produced by the hand of a skilful worker.

In relief work, such as ornamental iron, pressed paper, etc., some pretty effects may be produced by spraying a different colour to that of the ground in such a manner that only one side of the relief receives the second colour. This is effected by directing the spray from the side. Most readers will be familiar with these effects produced on

menu cards, concert programmes, etc.' The possibilities in connection with relief metal work are many.

Another series of effects in which brilliancy of colouring is required may be referred to in passing. Sometimes a bright red or a bright green is desired for the finish of a particular piece of work. In such cases a use of the process known as "colour glazing" is recommended. For example, an agricultural implement or any other article which it is desired should have a bright crimson finish can be first painted with Venetian or Indian red, by either spraying or dipping, and then have a coat of crimson lake, which will give an excellent effect. As the crimson lake is somewhat fugitive a protecting coat of varnish will be required.

All glazing colours may be applied by dipping, because, being semi-transparent, they are all very fine, and the coats may be thin, but the varnish should be applied by spraying or by hand. It may, of course, be of a variety suitable for baking or stoving if required.

This process is an alternative to using coloured enamels, and in some cases gives better results. Much depends upon the colour and the constituents of the enamels. Many of the lakes are very sensitive to a high heat, which changes the colour to a dirty brown. In such cases a final coat of stoving varnish, if carefully handled, will be safer than some grades of enamel.

Scumbling and Colour Glazing.

For convenience of reference we include a short list of glazing colours taken from Andrew Miller's "Scumbling and Colour Glazing," published by the Trade Papers Publishing Co., Ltd., 365, Birkbeck Bank Chambers, London, W.C.

Glazing.

The principal colours used for glazing are cadmium, crimson lake, Prussian blue, lemon and orange, chrome, yellow, Brunswick green, carmine, madder lake, Chinese blue, cobalt, indigo, gamboge, terra verte and emerald green. These colours may be used ground in either linseed oil, turpentine or water. Some of them are rather expensive, but the coat being very thin a little colour goes a long way.

Following is a list of ground colours with the glazing which may be used in conjunction with them. They by no means exhaust the range of effects, but are given as suggestions :—

Fig. 115.—Designs for Lamp Shades (Opened Out) Done by Spraying.

REDS.

APRICOT.—Ground made up with zinc white, middle chrome, and vermilionette, glazed with crimson lake.

BEGONIA.—White zinc, vermilionette and Prussian blue, glazed with brown madder lake.

CARNATION.—White zinc and vermilion, glazed with crimson madder lake.

CLARET.—Zinc oxide, Venetian red and vermilion glazed with brown madder lake; or zinc oxide and ultramarine blue, glazed with carmine.

CORAL.—White zinc, vermilion and lemon chrome, glazed with crimson lake.

FLESH COLOUR.—White zinc, yellow ochre and Venetian red, glazed with burnt sienna.

GERANIUM.—Bright Derby red and orange chrome. glazed with crimson lake.

LILAC.—White lead, vermilion and ultramarine blue, glazed with brown madder lake.

MAGENTA.—Zinc oxide and ultramarine blue, glazed with crimson lake.

PEACH.—Zinc oxide, vermilion and lemon chrome, glazed with cadmium (deep); or white lead and Venetian red glazed with carmine.

PLUM.—Zinc white, Indian red, and ultramarine blue, glazed with carmine; or white lead and Indian red, glazed with ultramarine blue.

POMEGRANATE.—Zinc white, Venetian red and lemon chrome, glazed with burnt sienna.

RUSSET.—Venetian red, orange chrome, lemon chrome, glazed with emerald green (thin).

ROSE.—Zinc oxide and vermilion, glazed with crimson lake; or white lead and lemon chrome, glazed with carmine.

TERRA-COTTA.—White zinc and Venetian red, glazed with burnt sienna.

BLUES.

AZURE BLUE.—Zinc oxide and ultramarine blue, glazed with cobalt.

BRONZE BLUE.—Zinc white and Prussian blue, glazed with black japan.

CHINA BLUE.—Zinc white, cobalt and raw sienna, glazed with indigo.

GOBELIN BLUE.—White, blue black, Prussian blue, glazed with emerald green.

MARINE OR SEA BLUE.—Ultramarine, ivory black, glazed with cobalt ; or white, raw sienna and cobalt, glazed with indigo.

METALLIC BLUE.—Zinc white and cobalt, glazed with emerald green ; or zinc oxide, Prussian blue, black, glazed with indigo.

MAUVE.—Zinc oxide and cobalt glazed with carmine ; or zinc oxide and celestial blue glazed with carmine.

PEACOCK BLUE.—Zinc oxide and ultramarine, glazed with emerald green ; or zinc oxide and Prussian blue, glazed with cobalt.

TURQUOISE.—Zinc white and cobalt, glazed with emerald green.

WEDGWOOD.—Zinc white, Prussian blue, glazed with terra-verte.

YELLOWS.

AMBER.—Zinc white, golden ochre, glazed with cadmium (deep) ; or white lead and lemon chrome, glazed with cadmium.

ANTIQUE BRASS.—Zinc white lead, orange chrome, glazed with Vandyke brown or black japan

BRASS.—Yellow ochre, white lead, orange chrome glazed with Vandyke brown.

CANARY.—Zinc white and Naples yellow, glazed with emerald green (thin).

CHAMOIS.—Zinc white and middle chrome, glazed with terra-verte.

CITRON.—Zinc white and middle chrome, glazed with brown madder lake (thin) ; or white lead, Venetian red, lemon chrome, glazed with Prussian blue.

DAFFODIL.—Zinc white, lemon chrome, glazed with burnt sienna.

GOLD.—Zinc oxide, golden ochre, vermilionette, glazed with raw sienna.

OLD GOLD.—Middle chrome, vermilion, burnt sienna glazed with cobalt (thin) ; or zinc oxide, Oxford ochre, glazed with burnt sienna.

PRIMROSE.—Zinc oxide, lemon chrome, Naples yellow, glazed with emerald green.

TOPAZ.—Zinc oxide, raw sienna, lemon chrome, glazed with cadmium (deep).

GREENS.

APPLE GREEN.—Zinc oxide, Prussian blue, glazed with cadmium (middle); or lemon chrome, zinc oxide, celestial blue, glazed with lemon chrome.

DUCK-EGG GREEN.—Zinc oxide, lemon chrome, glazed with Prussian blue.

EAU-DE-NIL.—Zinc oxide, lemon chrome, Prussian blue, glazed with emerald green.

GRASS GREEN.—Zinc oxide, Oxford ochre, glazed with cobalt.

IVY GREEN.—Zinc oxide, lemon chrome, burnt sienna, glazed with Prussian blue.

MYRTLE GREEN.—Zinc oxide and ultramarine, glazed with emerald green.

OLIVE.—Zinc oxide lemon chrome, burnt sienna, glazed with emerald green.

BROWNS.

CHESTNUT.—Yellow ochre and middle chrome, glazed with burnt sienna; or burnt sienna and orange chrome, glazed with Vandyke brown.

CHOCOLATE.—Burnt sienna, vermilion, ultramarine glazed with crimson lake; or burnt sienna and Indian red, glazed with Vandyke brown.

CHERRY.—Raw sienna and burnt sienna, glazed with raw umber.

NUT BROWN.—Venetian red, lemon chrome, zinc oxide, glazed with burnt sienna.

GRAYS.

COOL GRAY.—Zinc oxide and ivory black, glazed with Prussian blue.

DOVE.—White, ivory black, Prussian blue, glazed with terra-verte.

FAWN.—White, raw sienna, glazed with raw umber.

HELIOTROPE.—Zinc oxide, vermilionette, glazed with ultramarine.

LAVENDER.—Zinc oxide, ultramarine and carmine, glazed with cobalt.

MOUSE GRAY.—Zinc oxide, Prussian blue, glazed with burnt umber.

PEARL GRAY.—White, Prussian blue, and vermilion, glazed with terra verte; or zinc oxide, vermilion, glazed with emerald green.

SILVER GREY.—Zinc oxide, ivory black, glazed with indigo.

OPAL.—Zinc oxide, celestial blue, glazed with burnt sienna.

WARM GRAY.—Zinc oxide, Venetian red and ivory black, glazed with Vandyke brown.

WEDGWOOD GRAY.—Zinc oxide, Prussian blue, glazed with terra verte.

NOTE.—The terms "Zinc white, " "White zinc" used above, all mean pure zinc oxide.

SCUMBLING AND GRAINING.

It is sometimes desired to obtain a different effect from plain paint or enamel, and to either imitate graining, such as old oak or to give mottled effects. Both processes are produced by scumbling, which means that the ground and finishing colours are different in hue or in intensity, and that portions of the latter are removed to show part of the ground. Thus, in imitating oak, the ground might be painted with a mixture of zinc oxide and yellow ochre, and the graining colour be made of burnt umber and raw sienna. Both coats could be applied either by dipping or spraying, but while the latter is wet, portions should be removed by combs and by the thumb held over a piece of rag, both marks being intended to represent the grain of the wood. In other cases, the colours may be applied as before, and the last coat, while wet, be wiped away at the edges, or in the case of relief metal work, at the highest parts. Again, some excellent effects are obtained by using different colours for the two coats, as suggested, and stippling the second, while wet.

Space will not permit of a more lengthy reference to this part of the subject, but full information can be obtained from Mr. Miller's book already mentioned. Something should be said, however, about

BRUSH GRAINING,

because it is so very well suited for work of this character, and by its use some very pleasant effects may be produced.

In this case, a material such as "Matsine," or "Scumblette" is applied by spraying over a different coloured ground, and, while wet, this is "flogged," or a dry brush is drawn over the surface, removing hair-like parts which expose the ground colour beneath. Thus a very dark green or even black may be used over a white or nearly white

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Fig. 116.—Show Card Done by Spraying.

Fig. 117.—Another Example.

ground, or a very dark red over an orange chrome ground. Various metallic effects may also be produced on wood or other materials by using silver, aluminium, gold or copper leaf, and partly spraying over it a lacquer of suitable colour.

The actual graining can be done in the ordinary way by an expert artisan, but as a rule this would be too costly when perhaps thousands of iron or other goods are to be turned out in a short time. In such a case transfer graining paper is sometimes employed, but this also is somewhat costly. Bellamy's graining rollers are found to be very economical. This tool consists of a cylinder on the outside of which is engraved the grain of various woods, such as oak, mahogany, maple, satinwood, birch, walnut and ash. All that is necessary in working it, is to pass the roller over the surface immediately after the graining colour has been applied, when it will be found to remove some of the paint and give the appearance of graining. This appearance is considerably enhanced if the parts are softened after the roller is used by going over the work with a badger softener.

Marble Grounds.

For the convenience of those who are called upon to imitate marble for any class of work, the following information is given as to the colours to be employed for the ground colours.

White.—A dead white ground should be used mixed to dry hard and smooth.

Sienna.—White blended with a mixture of white and raw sienna in irregular patches.

Pink Marble.—The ground may be the same as that used for sienna, but a little Venetian red should be added to give it a pinkish cast.

Alabaster.—Light cream ground made by adding a little middle chrome and vermilion to white.

Rouge Grotte.—This is a very beautiful marble which contains a large number of different colours. The ground may be either white or Venetian red, mixed with a little chrome yellow.

Granite.—There are several varieties of granite, the principal being termed "grey" and "red" respectively. To mix the former ground, add a little black and Prussian blue with just a touch of Indian red to white. The grounds for red granites can be produced by mixing Venetian red and white.

ROUGE ROYAL.—A mixture of Indian red, Venetian red and vegetable black, with a little white, will make the correct colour for the ground of this beautiful marble. It is very necessary that the ground be quite "solid," and to produce this, two, or even three, coats may be necessary.

EGYPTIAN GREEN.—The ground should be a dead black.

VERD ANTIQUE.—The same as above.

DEVONSHIRE MARBLE.—Venetian red and ochre with a little white to produce a light terra-cotta ground.

BLACK AND GOLD.—A dead black ground should be used.

DOVE.—In this case a white ground without gloss may be employed, but a grey is better, such as that produced by tinting white with Prussian blue, a little black and a very little Indian red.

GREY.—The same as "dove."

ST. ANNE'S—A dead black ground should be used.

GRAINING GROUNDS.

POLLARD OAK.—The ground colour is prepared with a mixture of Oxford ochre, Venetian red and white lead in proportions, to form a rich buff; or white lead, chrome yellow and vermilion may be used.

KNOTTED OR ROOT OF OAK.—This ground is exactly the same as the above.

BIRCH.—The ground is prepared with white lead, a little Oxford ochre and a little Venetian red, of which latter, however, only sufficient must be used to make a very light buff colour.

MAHOGANY.—The ground colour is prepared with the best Venetian red, yellow ochre and a little white lead (or orange chrome may be substituted for the yellow ochre). If it is desired to increase the brilliancy of the colour, substitute vermilion for Indian red. If a light ground is required use the same colours as above, adding more white. The addition of a little vermilion will increase the richness of the colour.

ROSEWOOD.—The ground colour is mixed in the same manner as above described for mahogany, but a little burnt Turkey umber and Victoria lake is added.

SATINWOOD.—A little Oxford ochre added to white lead gives the proper ground for this wood.

WALNUT.—The ground is prepared with white lead, Venetian red and Oxford ochre, with a small quantity of burnt Turkey umber, but not so much as to destroy the appearance of the other colours and make them poor.

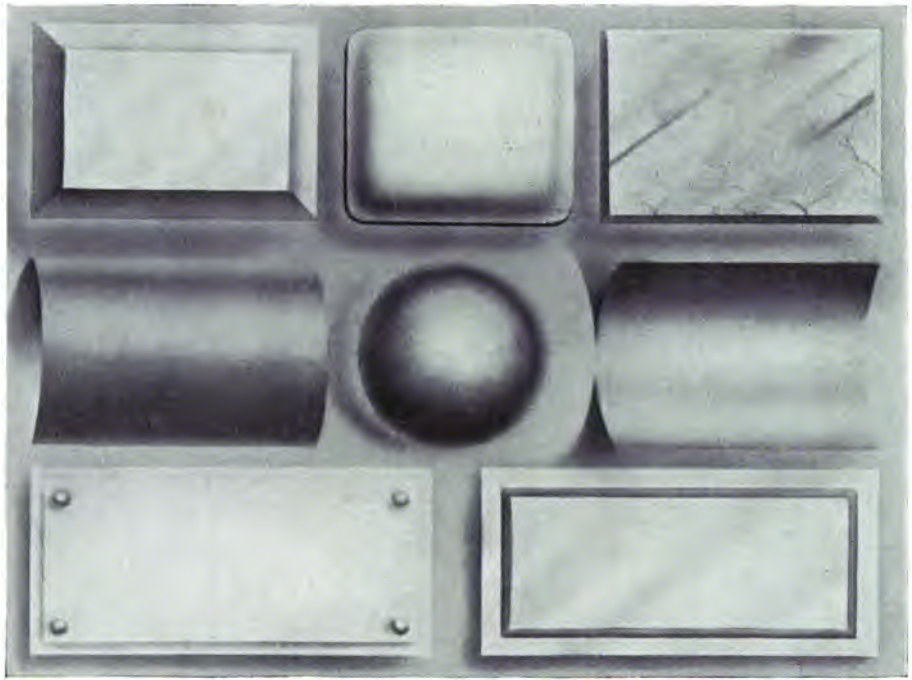


Fig. 118.—Showing the Beautiful Shaded Effects which may be Produced by Spraying (Strong).

Neither red nor yellow should be in excess, but all should be toned down with the umber. Although this colour may look dull when mixed, it is only a relative dullness, and it will shine out brightly enough when grained and glazed.

BIRD'S EYE MAPLE.—This ground may be prepared with either white lead and a little Oxford ochre, Venetian red or vermilion, but care must be taken not to use too much.

SATINWOOD.—The ground should be a yellowish white, obtained by adding yellow ochre to white lead.

NOTE.—Those who desire to obtain copies of marbles and woods printed in colour, from which to copy, should obtain either or all of the following books :—"The Art of Graining and Marbling," by James Petrie. Price 25s. The Trade Papers Publishing Co., Ltd., 365, Birkbeck Bank Chambers, High Holborn, London, W.C.; "The Art of Graining," by W. Sutherland. Price 25s. A. M. Sutherland, 26, Oxford Road, Chorlton-on-Medlock, Manchester; "Graining," by A. R. Van der Burg, 26s., Crosby Lockwood and Co., Stationers' Hall Court, London, E.C.

In Fig. 119 is given an illustration of a fruit dish, the ornamentation of which has been done by spraying. In Fig. 120 is shown a portion of a table cover done by the "Airostyle" on a fine art fabric.

There is, of course, no limit to the number of artistic designs which may be produced by applying the paint by compressed air; indeed, the air brush or spraying machine for this class of work produces results which cannot be obtained in any other way. Several of the engravings illustrate forms of advertising cards all done by spraying, while Fig. 118 illustrates very well indeed the different effects in form which may be produced by the spray properly used, such as the raised panels, the sphere in the middle and the convex and concave portions of cylinder. These examples are reproduced, with full acknowledgments, from the "Book of Designs" by Chas. J. Strong, of the Detroit School of Lettering, Detroit, Mich., U.S.A. The price of this book is £1 ($5.00), and it contains an immense number of useful designs suitable for the use of sign painters, show card writers and commercial artists. It may be had in London from the office of the "Decorator," 365, Birkbeck Bank Chambers, London, W.C.

CHAPTER XIII.

THE "FLOWING-ON" SYSTEM.

The very latest method of finishing automobiles which have steel bodies is that at present in use by the Ford Motor Co., Ltd., at Trafford Park, Manchester, and elsewhere. The method is a remarkable one not only because of the great saving of time it effects, but by reason of the fact that the "life" of the painted or enamelled surface is prolonged by the improved method.

Stated briefly, the process consists in coating the body with blue-black enamel by means of gravity only; that is to say, the enamel is placed in an elevated tank and discharged on to the work through a flexible pipe and slotted nozzle opened by a lever which is actuated by the thumb of the operator. Thus no spraying is required, while dipping is out of the question, as only the outside of the body is required to be painted.

Each coat takes two minutes to apply to the whole surface of a four-seated Ford motor body! An achievement which justifies our use of the word "remarkable."

But it will be convenient to explain how the present method came into use. Until a few months ago the several undercoats were sprayed on the work in the ordinary manner, but the finishing coat of varnish was flowed on by the gravity apparatus now referred to. Then it was thought that the undercoats might be applied by the same method, and some careful experiments having been made, it was found that by dispensing with the spraying and flowing on the coats a much more satisfactory result was obtained. As the new method caused more paint to adhere to the work than would be put on by the spray under ordinary conditions, one coat, it was found, could be dispensed with altogether. There was also less rubbing down required because of the very smooth coat obtained by flowing on, and, above all, the time of applying the coat was reduced to the extraordinarily short time of two minutes.

Fig. 119.—A China Fruit Dish Decorated with the Airostyle.

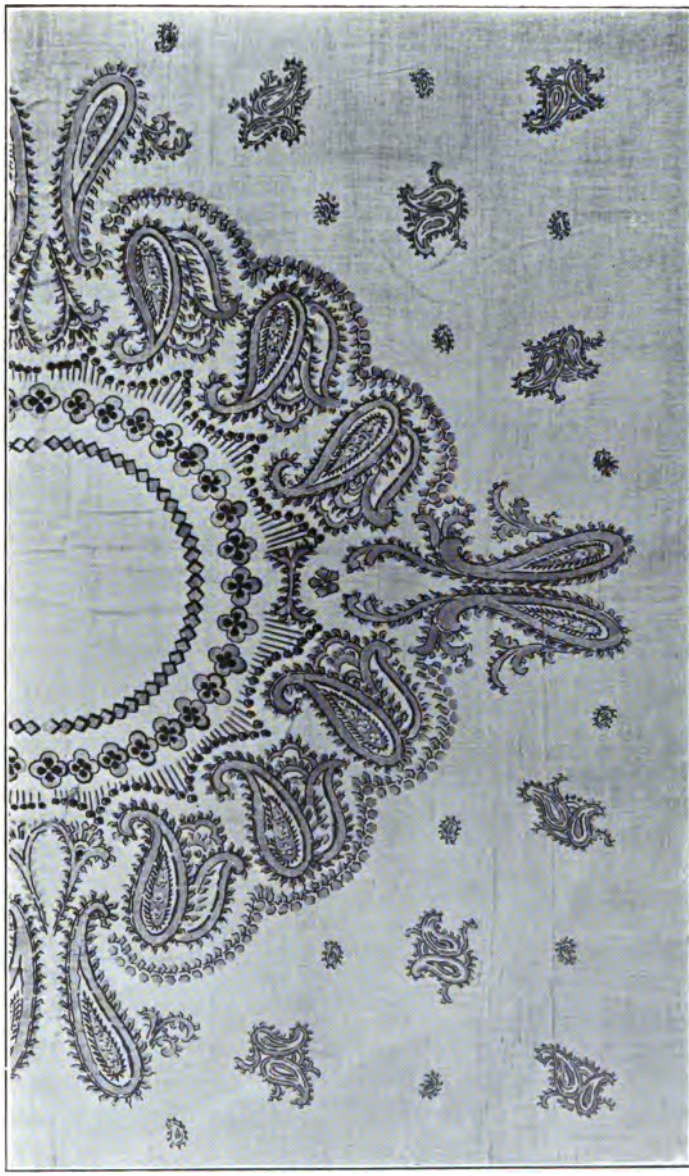


Fig. 120.—Table Cover Decorated with the Airostyle.

The apparatus employed for this work is of the simplest character. The car body is placed upon a platform mounted upon wheels. This is made of exactly the right size to fit between a V-shaped metal trough which surrounds three sides of the body and is intended to receive the superfluous paint, a considerable quantity of which drips into it from the body as the enamel is applied. This trough, a sketch of which is shown in Fig. 121, is slightly inclined so that the paint which drips off all runs to one point, where it passes through a gauze covered orifice, descends to a small tank beneath, whence it is pumped up to the elevated tank above and is then ready to be used again.

This elevated tank is cylindrical and holds, perhaps, 25 or 30 gallons. It is stationed overhead some 12 or 15 feet high. From this tank descends a flexible metal pipe or hose ending in a slotted nozzle, opened by a lever, which is operated by the thumb of the workman and is closed by a spring. This completes this simple though very effective apparatus.

The body of the car is made of stamped steel which has already received a protective coat of paint of a dull red colour, the body being placed upon the platform or bogie and being placed in position with the V-shaped trough surrounding it on three sides. The first or undercoat is given by rapidly passing the slotted end of the lever valve over the surface, upon which the paint literally pours out. The top part receives attention first and the paint runs down over the surface, which it covers completely, excepting perhaps here and there, where the discharge of paint is directed, and the whole of the outer surface of the car is, as already stated, completely covered in two minutes. This coat dries semi-flat.

In order that the discharge pipe may be kept nearly vertical and be moved around the car as the different sides are dealt with it is provided, at its upper end close to the point where it joins the tank, with a brass swivel union and a horizontal arm which swings around. A stop-cock is also provided.

The undercoat having been applied the body is allowed to rest for a few minutes until the dripping ceases. It is then wheeled on the bogie across the room to an oven, in which it remains for one hour at a temperature of 160° F. This heat is found to be sufficient to bake the paint but is not high enough to injure the woodwork which, of course, forms part of the body. At the expiration of the hour a little stopping of inequalities of the surface is usually found

necessary, but in any case the surface is lightly rubbed down with fine glass paper.

The body is now brought underneath a second tank with the V-shaped surrounding trough exactly as before described, and here it receives another coat of enamel or paint, which in this case has a little more body and gloss.

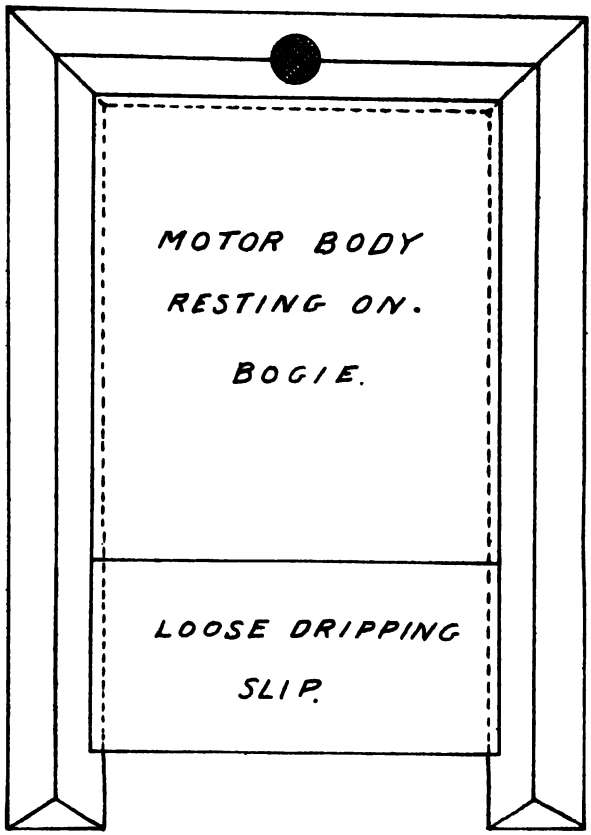


Fig. 121.—Sketch of Trough Tank Used in Flowing on Paint

After stoving as before and at the same temperature the surface is carefully but rapidly rubbed down with powdered pumice stone and water applied by means of felt pads.

There are a series of four troughs and tanks in all, corresponding in number with the coats to be applied. From the third one the body receives a third coat, is then baked

or stoved, rubbed down with powdered pumice and water, thoroughly cleaned off, and from the fourth tank receives the final coat of varnish which completes the operation. This coat of varnish is not stoved but is air-dried. The finish is a blue-black picked out with very dark blue, and it is free from any signs of runs or drips ; in fact, no one could tell how the application was made. As already remarked, the coats of paint are somewhat fuller than would be the case if they were applied by spraying, and the durability is thereby increased.

The output from this department is 70 cars a day, a number which would be practically impossible if the work were not so splendidly systemised.

It should be observed that the varnish is applied in a separate room from that used for the application of colour. This is done in order to exclude dust, and also to maintain the temperature at 90° F.

In considering the essential points of this method of finishing motor bodies, it is clear that the system might be successfully applied in very many other industries to a great variety of goods. The apparatus is so simple in character that no engineer would have the least difficulty in designing a plant suitable for any particular requirement.

It must be admitted that the crux of the whole situation is the kind of paint or enamel used. It must be sufficiently viscid to hold on to the surface to which it is applied, sufficiently liquid to run off freely without leaving runs, tears or "fat edges." And, above all, it must flow out uniformly. All these conditions, however, apply also to a dipping plant, and only require careful consideration on the part of the paint manufacturer who has made a special study of the subject. The varnish applied by this method must also be of a special character so that it may flow out nicely without yielding too thick a coat, which would be likely to lead to blemishes. Ordinary paint, enamel or varnish, then, will not answer for this class of work, but special products must be employed, and when these are obtained, the rest is comparatively easy.

The Floco Process.

This process is in some respects similar to that above mentioned, the difference being that it is intended principally for the application of varnish by flowing over a painted surface done by spray. The essential difference in the apparatus is that the varnish, instead of being discharged

by gravity, is pumped up from a tank. It is largely used in America, and is manufactured by the De Vilbiss Manufacturing Company, Toledo, Ohio, U.S.A. It is particularly suitable for automobile bodies and large surfaces generally.

The process flows such materials as varnishes, enamels and japans, when it is impracticable to spray them. It has superseded the inadequate, inefficient flowing systems used in the past, and is also replacing brush and dip methods as practised in many instances.

The equipment of the process comprises a 15-gallon tank, drawn from one sheet of steel and heavily tinned; 1-6 H.P. motor, housed in, driving a rotary pump; regulator; nozzle; electric fittings; flexible fluid hose, and galvanized iron drain trough on rack. All parts, excepting nozzle, hose and trough, are mounted on a castered truck for moving about. The truck is equipped with a rack around which to wind the hose when not in use, and a holder for the nozzle.

Fig. 122.—The "Floco" System of Painting Motor Bodies.

The finishing material, such as varnish, to be used is pumped from the bottom of the tank by the electric motor-driven pump, in a continuous stream, through the flexible hose, to the nozzle. The flow of material is adjusted by

Fig. 123.—Show Card Done by Spraying (Strong).

the regulator, by means of which a varying amount is not put into use and returned to the tank. In this way the flow from the nozzle is instantly adaptable to any class of work and viscosity of fluid without changing the speed of the motor.

When the nozzle is closed the material pumped is all forced back into the tank through the overflow. This serves to agitate the material; in fact, is the only agitation necessary with material containing pigment, such as colour varnish.

The body to be flowed is—as shown in Fig. 122—placed over the drain trough. The operator first applies the material all along the top, then flows it copiously over the upper half of the surface. Sufficient material is thus applied to insure a perfect flow to the bottom. The job is allowed to drain into the trough which carries the material back to the tank—here it is strained and, without the slightest waste, used again.

Only enough material is put into the tank to take care of the work at hand, or to handle the day's production. The maximum amount of material exposed is 15 gallons —the tank's capacity. The nozzle will operate satisfactorily on a gallon of material.

The tank, motor, pump and regulator are—as previously stated—mounted on a truck fitted with casters, permitting of these parts being moved about with the greatest of ease. Another appreciable advantage of this style of arrangement is that an extra truck can be kept on hand and put into immediate use in case of accident.

The cleaning of the parts is simple. The nozzle of the machine is detached and all of the material pumped out of the tank, after which a small quantity of naphtha—or some other similar solvent—is put into the tank and pumped through the machine.

As the motor is only 1-6 H.P., the consumption of power is low. The motor is made for all kinds of current, and can be attached to any light socket.

It may be observed that the pressure tank used in this equipment permits of the use of heavier or more viscid enamels and paints than would be possible where gravity was depended upon. In view, however, of the success which has been met with in the case of the Ford Motor Company, there appears to be no reason why the Floco process should not be used for some of the undercoats, as well as for the finishing.

The following article by M. C. Hillick appeared in "The Painters' Magazine," of New York, and will doubtless be read with interest :—

The Willys-Overland automobile factory has recently been installed with sixteen large enamelling furnaces or ovens having a volume of 48,000 cubic feet and a capacity of 140 tons of enamelled product every ten hours. These ovens have been electrified and they require approximately 5,500 horse-power. For some months past the Overland Company has been testing one of these electrically-heated ovens, and the results have, in every way, measured up to expectations. Formerly the company, in common with practically all other companies using enamelling or baking ovens, employed gas as the treating medium. The ovens now electrified are almost entirely automatic in operation. When the oven is loaded the closing of its doors automatically throws a switch which turns on the current. A pyrometer which can be adjusted to operate at any desired temperature rings a bell when the proper degree of heat is reached, thus notifying the attendant, and also automatically turning off the current. The electrically heated oven does away with all flue gases and with their attendant dirt and spots. It also reduces the required volume of ventilation to the minimum, thereby eliminating air currents and the dust which, in greater or less degree, usually accompany them. The electrification of the ovens does away with explosions, banishes danger from fire, and gives an assured "safety first" to the workmen. The heat is said to be non-oxidizing and, therefore, cannot scald the operator. The working quarters are rendered comfortable and a higher grade of work is made possible.

While for the custom shop painter it is a long way to such equipment, the fact that these facilities are gradually being acquired leads to the assumption that, in the course of a few years at most, some portion of the work coming to the shop for painting repairs will be handled through the baking oven. In connection with this subject of enamelling and oven baking, the various costs of paint and varnish, it is to be noted that the excessive temperature employed in baking is being criticised as detrimental to the finish. Recent tests are said to have been made which show that baking paint and varnish at the maximum temperature shortens the life of the finish. Mr. J. W. Lawrie, of the Chemical Works of Milwaukee, Wis., has stated that, as a rule, the lower the temperature and the longer the time

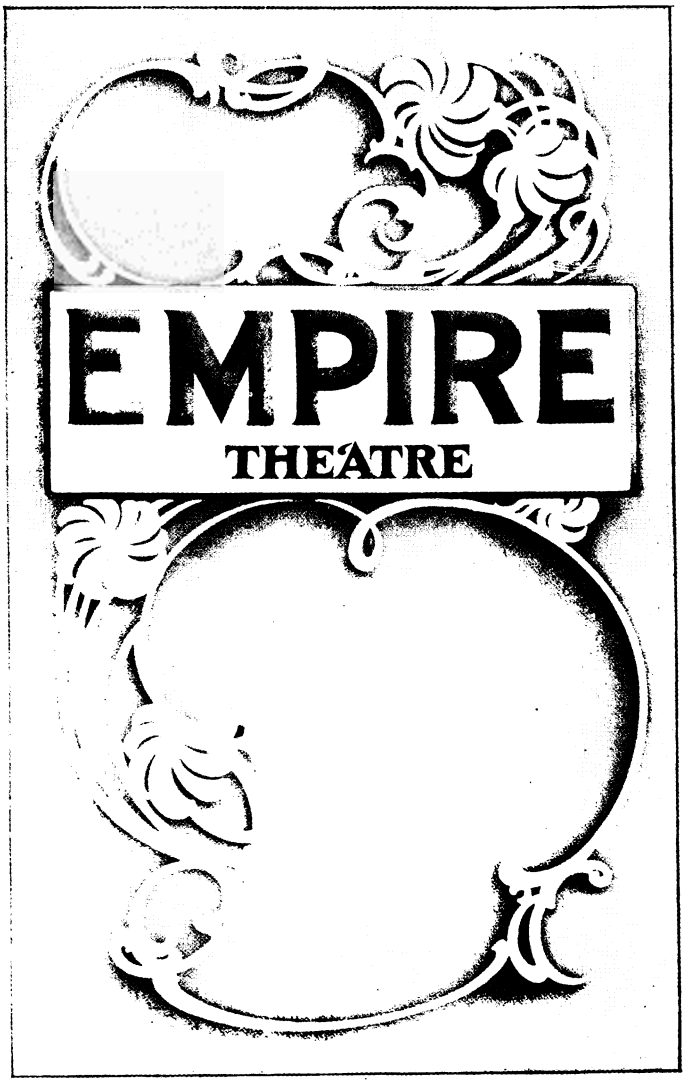


Fig. 124.—Show Card Done by Spraying (Strong).

the paint and varnish is baked, the finer the appearance, service and durability of the finish and the greater its capacity for resisting moisture. The finish will have more elasticity and deeper lustre. Mr. Lawrie is of the opinion that twelve hours at 180 degrees are better than five hours at 280 degrees.

In some motor car shops, within the past two years, by the use of baking ovens cars were painted and finished, all coats being baked, and made ready for service in three days. However, we are not commending or recommending this practice. For the custom shop painter, especially, it is entirely unsuited. Nor would we recommend the baking process for surfaces other than metal. The same disadvantages marshalled in opposition to baking paint and varnish upon wood surfaces fifteen years ago, or longer, still remain in evidence. For aluminium, sheet steel or other metal panels or metal surfaces in general, the baking process offers an opportunity for finishing work under conditions more uniform than any which may be expected to prevail outside the oven. Another advantage is noted in favour of oven baking. It permits the use of more elastic materials without the aid of artificial oxidizing agents. As compared to the present air-drying system, the oven baking method, operated upon a conservative basis, permits the car to be thoroughly painted and finished in six or eight days. The use of more elastic materials—paints, colours and varnishes—has been mentioned as a part of the oven baking method. Upon steel surfaces this is perhaps more necessary than upon aluminium, and possibly iron. Steel has a linear expansion double that of wood. As a matter of fact, experts in these matters employed by the Pennsylvania Railroad assert that the contraction and expansion of steel surfaces is much more pronounced than the same action in wood. Materials of greater elasticity as compared to those used in natural air-drying practice are urged.

Primers and surfacers, and the general class of foundation coats, will require an average of three hours' baking at 200 degrees F. While some colours require higher degrees of heat than others, 170 degrees F. baked for, say, six hours will dry the average colour, excluding white. The latter pig ment, baked at a temperature varying from 85 to 110 degrees F., will dry properly in the course of a few hours, and retain its natural purity of colour, whereas at a higher degree of heat the white takes on an objectionable yellowish cast

Black, at the opposite end of the colour pole, can be safely baked for six hours, at something like 200 degrees F. Finishing varnishes, taking them as they run, will bake at from 110 to 150 degrees F. for five or six hours. In all baking practice the personal equation figures largely. Reason, good judgment, the capacity for taking pains—all these are items of importance.

Oven baking methods are being successfully employed in some of the large city repainting establishments. A firm near New York, for example, using what is known as the radio process, paints and finishes a car in three days. The cleaning of the cars is accomplished by the use of a steam jet, a treatment which is said to cut away the grease like magic. All surface defects following the cleaning of the car are touched up and faced over with the necessary filling and surfacing materials. Then these patched-up parts are rubbed down with water and rubbing brick, and the general surface of the car is lightly rubbed with pulverized pumice stone and water. All colour, and varnish colour, coats are applied with a paint atomizer. This atomizer is a pistol-shaped device operated with a trigger, the material being sprayed from the muzzle of the barrel. The varnish colour is baked for three hours at a temperature of from 110 to 120 degrees. From 90 to 100 degrees of humidity are provided for the oven, and by means of an exhaust fan a fresh supply of air is furnished every three minutes. In the oven where the varnish colour coats are baked a thermostat is installed, which regulates the temperature. All the air entering the oven is washed and purified by running it through a water tank before it enters the oven. This water-washed air is forced into the oven by a fan blower, and contact with a radiator superheats it.

In practice, the high humidity here referred to, and the water-washed air, are mediums which serve to keep the outer surface of the drying coat moist while the inner surface is drying, in this manner furnishing in due time a paint film dried uniformly from top to bottom.

The finishing varnish is dried in an oven having a maintained temperature of from 90 to 100 degrees, the humidity being regulated at from 60 to 70 degrees. This humidity is likewise found to assist a varnish film to dry uniformly throughout.

The treatment of the car chassis in the establishment here referred to is quite similar to that given the body of the car. A steam treated potash bath is provided into

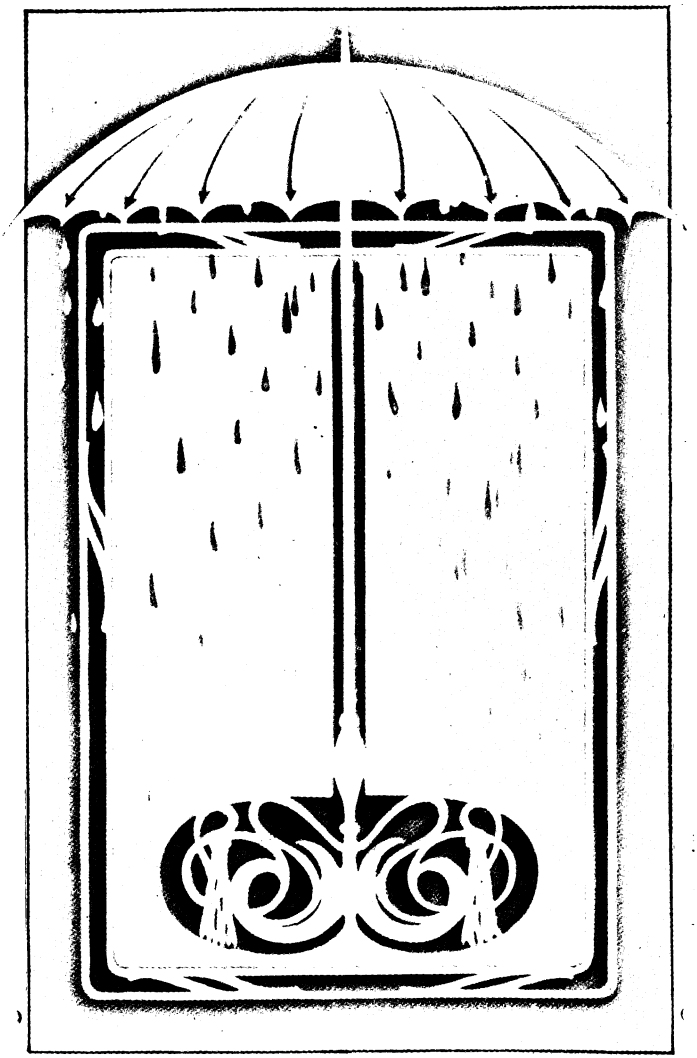


Fig. 125.—Design for Show Card (Strong).

which fenders and other removed parts are immersed, removing all grease and foreign substances, and even the paint, from such parts. These parts, after cleaning, are then dropped into tanks containing the required paints, varnish colour, etc., after which they are taken out and drained and then consigned to an oven maintained at a uniform degree of heat.

Other establishments having ovens installed are employing methods designed to secure equally quick results without sacrificing any measure of durability or appearance.

In the absence of ovens, not a few car and carriage painters are practising the so-called hot-air method as far as possible. Successful results are reported in many instances, the work being turned out quicker, with an increase in lustre advised in some cases. This method is very simple and requires no previous experience or special training. Anyone capable of providing the necessary degree of heat—85 to 95 degrees F.—and maintaining it for eight or ten consecutive hours, can have the benefit, in full measure, of the hot-air system. Coats of paint, colour, varnish colour and varnish dry rapidly in a temperature at the above degree, where the ventilation is good and a fair volume of pure, fresh air can be constantly brought into the drying room.

Notes on the Construction of Stoves.

The construction of stoves for use in connection with enamelling and baking japans generally does not properly form part of this treatise, but a few remarks on the subject may be of service. It is to be regretted that in only too many cases the stoves employed are very inadequate. In some cases they are heated by gas, and the jets cause a certain amount of discoloration. This is objectionable even when the work is black, but if it is coloured it may lead to serious disadvantages. In Fig. 126 is shown a sketch of what is known as the "Perkins System of Heating." It is largely adopted in many trades for enamelling cycle frames and parts, lamps and motor horns, etc. It is this system which is used by Messrs. Lucas, Limited, of Birmingham, a description of whose plant is given elsewhere. In the "Perkins" system water is heated under pressure, and the comparatively high temperatures required for drying and other similar purposes are obtained in a simple but efficient manner.

The apparatus consists of circulations of hydraulic tubing, certain proportions of which are formed into a coil

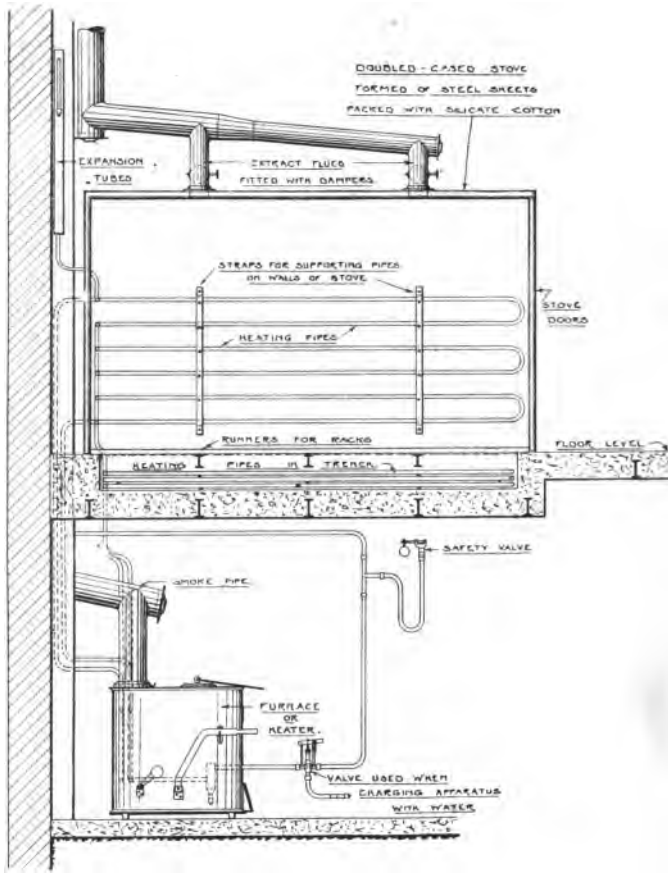


Fig. 126.—THE PERKINS STOVE.

and placed in a furnace situated in any convenient position outside and below the drying chamber. The apparatus is hermetically sealed and self-contained, the heating water circulating from the furnace through the heating pipes or coils and back again to the furnace without any loss through evaporation. No pumps or moving parts of any description are required, so that unskilled attention only is needed.

The illustration shows a simple application of the apparatus, which is the type often employed for cycle and motor

parts, bedstead frames, electric apparatus parts, etc. The arrangement of the pipes, of course, depends upon the class of work which has to be dealt with.

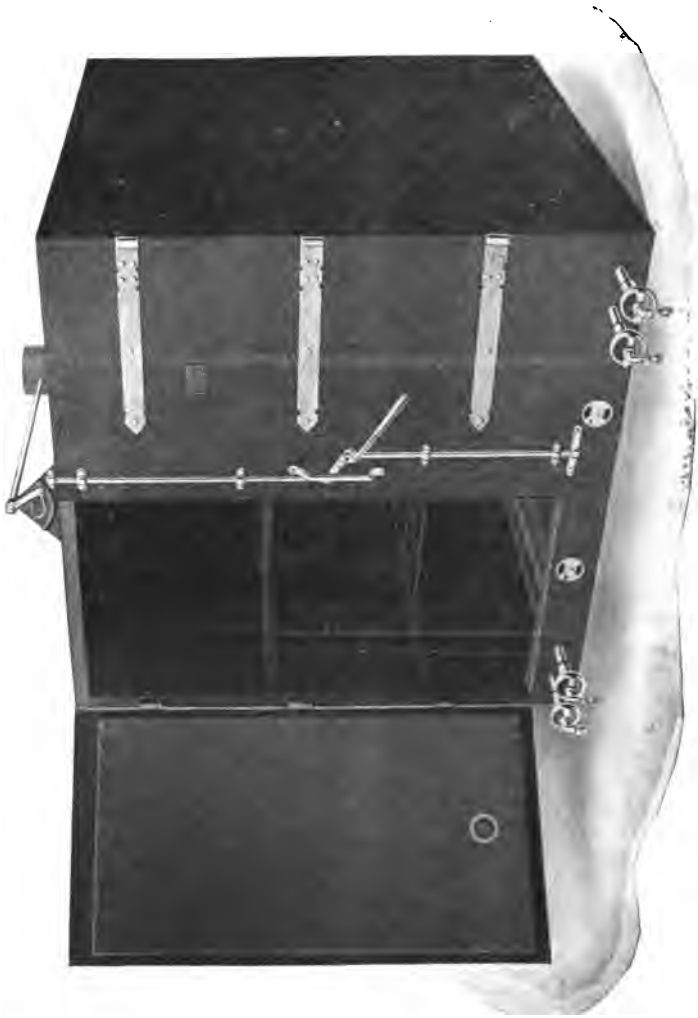


Fig. 127.—A Typical Goodyear Stove.

In Fig. 127 is shown a type of stove manufactured by Goodyear and Sons, Churchfield Works, Dudley. The construction is a great improvement on the old-fashioned

type of enamelling stoves, which through faulty design were responsible for great loss through radiation and combustion. The work done in such stoves is necessarily inferior. The firm named are among those from whom may be purchased up-to-date stoves heated by gas (ordinary lighting or producer), steam, superheated water, and oil, either single, double, or treble cased suitable for purposes which a few years back were hardly dreamt of, and which

Fig. 128.—Dipping Trough.

may be said to range from hairpins to bedsteads, and include munitions of war, such as stoves for shell drying and varnishing. A very important part of the process of stoving is the rack and trolley system of transport in and out of the stove, which in effect means that no article is too heavy for such process. In the production of stoves for enamelling certain firms have made a special study of the requirements, including those above mentioned.

Fig. 129.—Show or Menu Card (Strong).

Fig. 130.—Example of Metal Decoration—Lid of Coal Box Done with Airostyle.

CHAPTER XIV.

LIME AND WHITEWASH SPRAYERS.

As explained in previous chapters, this type of machine is of an entirely different and much simpler construction than those used for spraying oil paint, varnish, etc. Yet such apparatus is used to a very considerable extent in factories of all kinds as well as for spraying insecticides on fruit trees and other purposes of the agriculturist. By the Factory and Workshop Act of 1901 it is provided that "all walls and ceilings must be limewashed at least every fourteen months, and painted and varnished work must be washed with hot water and soap at the same periods. Special exceptions to this rule may be made by Special Order." Such an order was made in 1911, which was to the effect that "when at least two coats of washable water paint or sanitary distemper is used instead of limewhite the period for renewing with one coat of such paint shall be three years. The paint, however, must be washed at least once in every three months." It is provided in this Order that "If it appears to an inspector that any part of a factory to which the exception applies is not in a cleanly state, he may, by a written notice, require the occupier to limewash, wash or paint the same; and in the event of the occupier failing to comply with such requisition within two months from the date of the notice, the special exception shall cease to apply to such part of the factory. In this Order a washable water paint means a washable paint which, when finished for use contains:—(i) at least half its weight of solid pigment containing not less than twenty-five parts by weight of zinc sulphide as zinc white (lithopone) in each hundred parts by weight of solid pigment and (ii) at least ten parts by weight of oil and varnish to each hundred parts by weight of solid pigment."

It should be stated that the type of machine now under consideration may be used for the applicatfon of such paint

or distemper provided that it is rendered sufficiently thin by the addition of water. If very thick compressed air will be required as in the case of ordinary oil paint.

An excellent machine for applying limewash, whitewash or distemper is made by Messrs A. C. Wells and Co., Engineers, London and Manchester. It is used to a very large extent by engineers and in factories, breweries, car sheds, cattle docks, etc. Builders, decorators, corporations, etc. also find it of great service for special work. The manufacturers state that over 5,000 of these machines have been sold, and that they are fast taking the place of the old method of limewashing with the brush. The speed with which lime, whiting or cold water paint can be applied is

Fig. 131.

Fig. 132.

from 10 to 20 square yards per minute. A very distinct advantage of the machine over brushes is that when an irregular surface, such as a brick wall, the joints of which are not by any means perfect, is being dealt with, the lime or distemper is forced in by the spray into the interstices which could not be reached by the brush. These machines consist essentially of a pump with spraying nozzle which is made in various forms, the simplest of which is that shown in Fig. 131.

This machine is designed to stand rough usage. The pump is simple and easily removable for repairs, and the spraying nozzle, which is naturally an important feature, can be regulated to any degree of fineness. A patent filter is provided which prevents clogging. It will be observed by the illustration that wheels are provided which enable the

Fig. 133.

Fig. 134.

machine to be easily removed from one place to another. A 15 ft. armoured delivery hose and 5 ft. spraying pole for reaching the upper portion of a surface to be sprayed is provided. The capacity is 8 gallons. The machine shown in Fig. 132 is somewhat smaller and cheaper. It contains 6 gallons.

Fig. 133 shows a machine with a double spraying nozzle and valve arrangement. This has several advantages over

the single pattern; the speed is almost double, and one jet can be put out of action if desired when working in cramped places. It is a powerful machine with 12 gallon tank and strong lever pump. It is supplied with large wheels and is easily moved about, and is eminently suitable for anyone having a large quantity of work to do quickly.

In dealing with very high buildings either the single or double nozzle is attached to a bamboo pole, as shown in Fig. 134.

Fig. 135.—The Brown Sprayer with Extension Rod.

In Fig. 135 is shown an excellent machine suitable for spraying whitewash, distempers and disinfectants. It is manufactured by the E. C. Brown Co., of Rochester, N.Y. The pump is of a simple but effective character; the valves are located so that they can be opened instantly and are fitted with springs so that the operator can pump while the machine is pointed in a downward direction. The strainer has five inches of screen surface and the screen can be instantly removed and cleaned. The pump barrel projects beyond the hand and serves as an extension rod. The

nozzle is guaranteed not to clog, and is fitted with Messrs. Brown's patented screen arrangement. It throws four different kinds of spray, one a solid stream, the second a broad carrying spray, the third a long driving spray for ceilings and tops of walls, and the fourth a fine spray which may occasionally become of service for spraying work near at hand.

There are several other makes of machines suitable for whitewash spraying, among them one manufactured by Merryweather and Co., Greenwich Road, S.E., The Bean Spray Pump Co., Los Angeles, California, U.S.A., and the Four Oaks Spraying Machine Co., Sutton Coldfield, Birmingham. The last named is particularly well adapted for spraying insecticides upon fruit and other trees.

Fig. 136.—THE MERRYWEATHER LIMEWHITE SPRAYER.

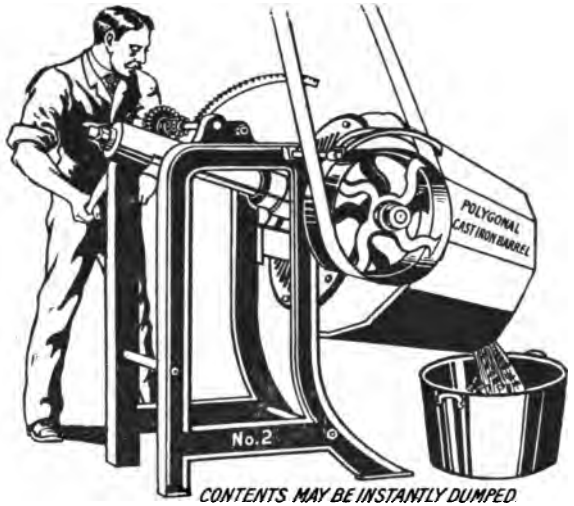


Fig. 137.—A Tumbling Barrel.

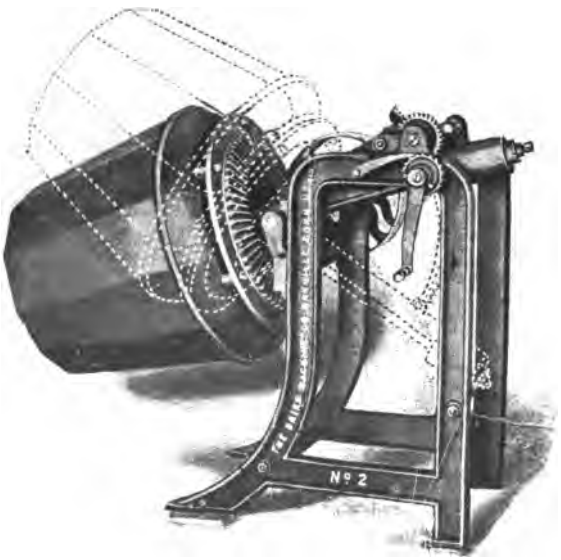


Fig. 138.—Another Form.

The Tumbling Barrel Process.

This process of japanning small castings is very successful in those cases where the parts are small and intricate in construction, and, therefore, cannot either be dipped or sprayed, excepting with some difficulty. The great advantage of tumbling is that such work is done better and faster than by dipping. A machine, of which two examples are shown in Figs. 137 and 138, is used in this process. Inside this machine are placed a number of shot or steel balls of different sizes. The articles to be treated are then introduced in the japan and the machine is started at varying degrees of speed. The shot carries the japan over the various parts and into the interstices. As different objects and materials require different speeds, some work will be started slowly and the speed increased to get the desired finished. The objects are then dumped out on to wire screens or baskets, and shaken, when the steel balls and shot fall through the mesh, leaving the articles that have been japanned behind. The baskets are then hung in baking ovens, while the balls are washed in gasoline ready for use. The machines mentioned above are manufactured by the Baird Machine Co., Bridgeport, Connecticut, U.S.A. The English agents are R. Cruickshank, Ltd., Camden Street, Birmingham.

CHAPTER XV.

A Portable Paint Sprayer for Railway and other Work.

Mr. M. E. McDonnell, Engineer of the Pennsylvania Railroad Company, Altoona, Pa., U.S.A., very kindly furnishes the author with the drawings which will be found on the following pages. He says :—The Company does very little painting by dipping. The spray process is, however, used very extensively, a large percentage of our freight cars having been painted by this method for years. The method is very satisfactory and also economical. The saving in the cost of labour in the spraying method is approximately 60 per cent. In some cases the saving is greater than this. In one of our largest shops the cost of application per unit for a given number of square feet is thirty-eight and nine-tenth cents with the spray as compared with one dollar with brush. It might be said that more paint is applied per coating when the brush method is used. A given surface which would require 10 gallons of paint for one coat by the brush method would require approximately 7 gallons by the spray method.

When painting a freight car a more uniform coating is obtained when the brush is used, due to the fact that the paint can be brushed out behind ladders and other things which would obstruct spraying, while in the application of the paint with a sprayer it is necessary to apply a thicker coating at certain points in order to reach other points which are obstructed, and which must, therefore, be approached from a side angle. The spray however, reaches certain crevices which cannot be reached with the brush, which is in some cases advantageous with the painting of freight equipment cars. Our Company would not consider returning to the brush method of painting.

The machines which we use for spraying the paint are made in the Company shops.

The following is a description of the apparatus referred to :—

It consists of a stout steel cylindrical receptacle 11½in. internal dia. by 24in. in depth, and having a capacity of about 12 gallons. It is supported on a special wheel-barrow of wood with trundling wheel of cast iron. The bottom of the receptacle is so low down that it rests on the ground when in use, by lowering the handles of the barrow. The paint is placed in this cylinder and is forced out by air pressure, introduced through the lid of the receptacle, at from 80 to 90 lbs. pressure per square inch. This air is provided from the shop compressor range or by a separate compressor. The paint pipe penetrates the cover and is extended nearly to the bottom of the receptacle. The air pressure on the surface of the paint forces it through this pipe to the atomizer.

A branch from the air supply is also taken to the atomizer and a third air branch taken to the bottom of the receptacle and carried through a 1in. iron pipe stopped at the end with a screw plug, but perforated with a number of ⅛in. holes. This latter is for agitating the paint and prevents settlement. The atomizer is shown clearly in the drawing. It consists of an air jet impinging on a vena contracta nozzle and surrounded by the paint forced through from the receptacle. The air blast carries the paint through the orifice immediately opposite to the nozzle and there reduces it to a fine spray. A hose is attached to the exit of the atomizer and the atomized paint is carried by the blast to the spray pipe, which is slightly fan-shaped and flat.

The cover is fastened by four hook-clamps, and is, therefore, readily removable. An air pressure gauge reading to 120 lbs. is also provided, and the valves are so arranged that the regulation of both the paint and the air supply are easily adjustable.

It will be noticed that, in the atomizer, a vena contracta is arranged so that it may be adjusted in its position in relation to the air orifice. The use of this is to provide for paint of various consistencies. Very great care has been taken in designing the details ; as, for example, the provision of a scraper to clear off accumulations from the periphery of the trundling wheel.

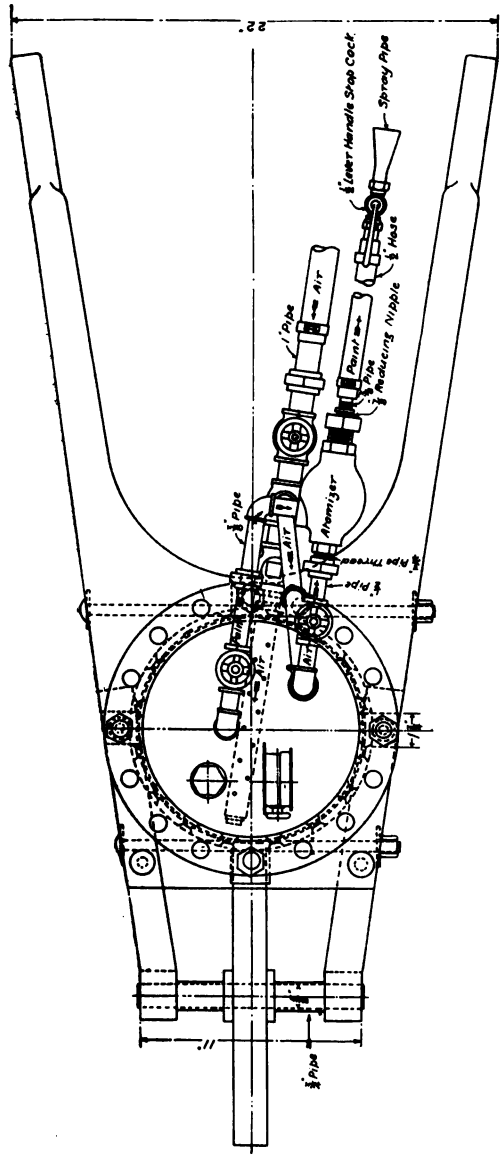


Fig. 139.—Plan of Paint Spraying Apparatus Used by the Pennsylvania Railroad, Principally for Freight Cars.

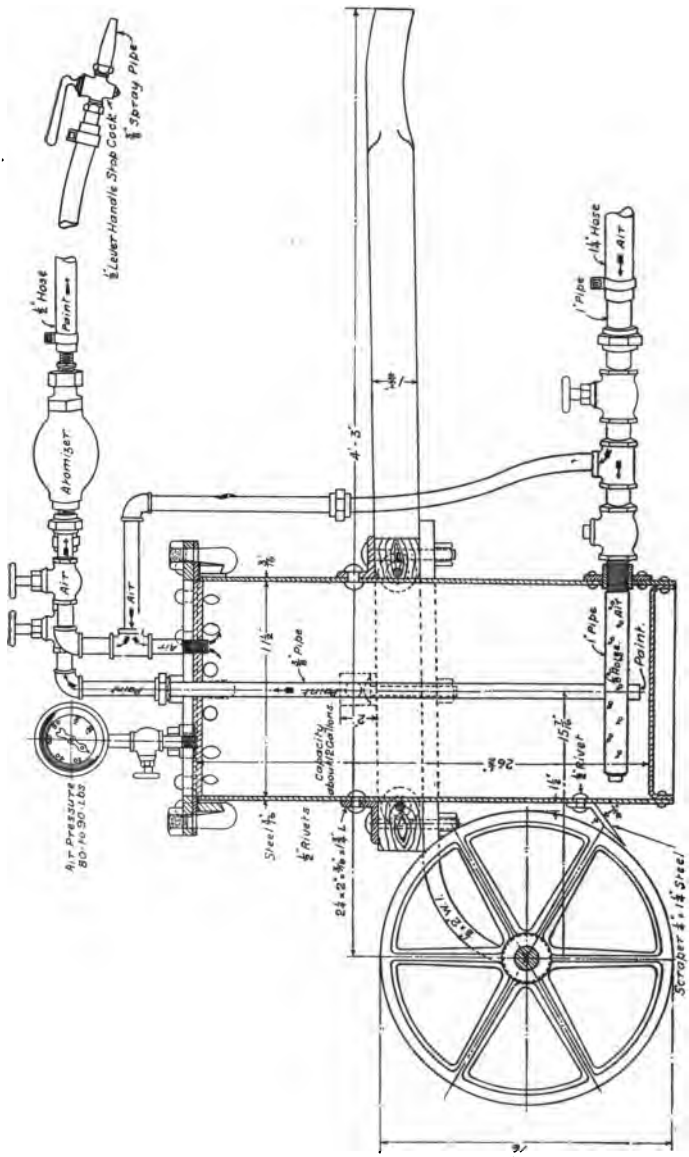


Fig. 140.—Elevation of Apparatus Shown in Fig. 139.

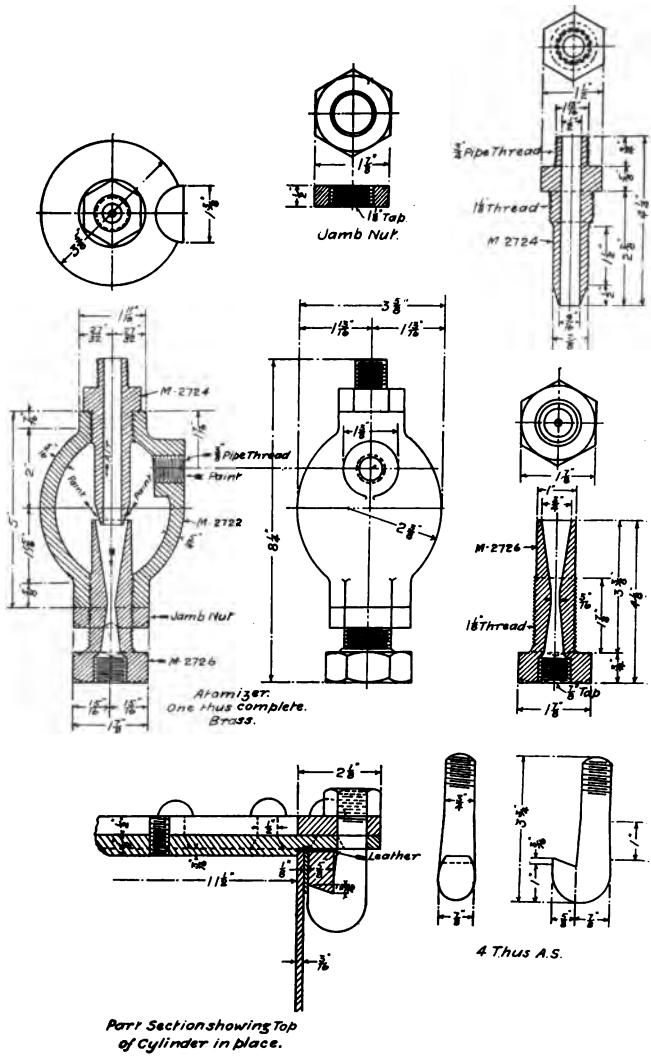


Fig. 141.—Details of Apparatus Shown in Figs. 139 and 140.

CHAPTER XVI.

METAL SPRAYING.

Although the spraying of metal does not really come within the scope of this book, the process is so closely allied to paint spraying that it is considered advisable to devote a chapter to the subject, particularly as the perfected process is of very recent date, and bids fair to be used successfully in many industries. It should be stated at once that a metallic coating may be applied to practically any surface, and that almost any metal or alloy may be employed.

Stated briefly, the process consists in melting metal in the form of a rod or wire, by means of oxygen and coal gas, or other gas, depending upon the metal used. The molten metal is sprayed at a high pressure, and a surface may be quickly covered with the metal of any desired thickness. A remarkable fact concerning the process is that the metal is cooled to an extent that renders it possible to hold the hand in the jet so as to receive a coat of metal without inconvenience, and samples of wood and fabrics may be coated with metal without injury.

A moment of consideration will render it clear that there is an immense field for this process; for example, as aluminium can be sprayed, a lining of that metal might be given to brewers' and cooking utensils, etc., while tanks, barrels, reservoirs, intended to contain acids and oils, can also be treated. In the production of blocks for printing, in decorative work and mural decoration, there is an immense field, while ships' bottoms, instead of being painted with composition, can be copper-plated or sprayed with any other suitable metal, in order to prevent incrustation. No doubt some very beautiful effects can be produced by means of the process.

It will be convenient now to describe the machine used for the application of the metals. It consists of a pistol

rather bulkier, but not unlike in form, the usual spraying apparatus, see Fig. 142.

In Fig. 143 is shown very clearly the construction of the sprayer, which it will be understood comprises a combined melting and spraying jet and a feed mechanism. The metal, in the form of rod or wire, is fed to the melting flame. This, as already stated, is formed by coal gas burned in the air, or oxygen, water gas, acetylene, hydrogen, etc., may be employed instead of the coal gas. The gases are supplied at such a pressure as to prevent blowing out and to ensure a

Fig. 142.—The Metal Spraying Machine or "Pistol."

highly deoxidizing flame. The spraying jet can be of carbon dioxide, nitrogen, air, steam, etc., and it must be fed at such a pressure as to produce a sufficiently high velocity for successful coating. The usual gauges and reducing valves will, of course, be employed. The feeding of the wire is accomplished by a small pneumatic motor, driven by the spraying medium, either in series or parallel with the main

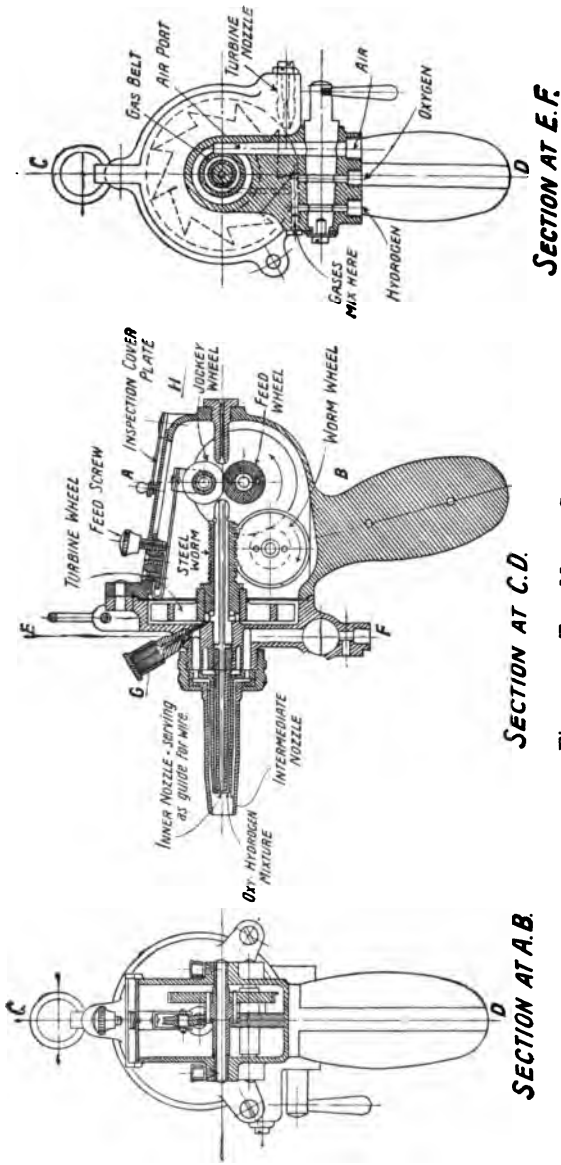
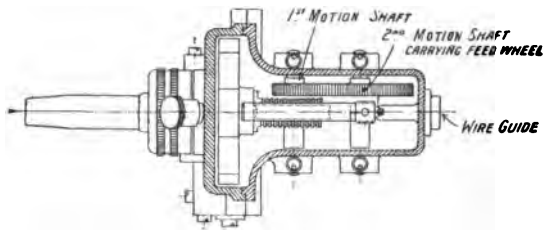


Fig. 143.—The Metal Sprayer.

jet. The dimensions of the wire nozzle, and feed mechanism, vary with the different metals. To obtain a good adhesion between the metals being sprayed and the surface to which it is to be applied, the latter must be thoroughly clean and of an open nature, to give a key for the deposit. Sandblasting is sometimes employed to effect this.

Fig. 145 shows an enlargement of the nozzle with the different parts marked. The cost of the process is not prohibitive; the cost of the metal only on one square foot of a thickness of 0·001 inch is quite small with the cheaper metals. The process is put on the market by the British Metal Spray Co., Ltd., Queen Anne's Chambers, Tothill Street, Westminster, London, S.W.

In a paper read by Mr. R. K. Morcom before the Institute of Metals, the following interesting information was given :—



SECTION AT G.H.

Fig. 144.—Sectional Drawing of the Metal Spraying Machine or "Pistol."

With a given design of jet there is only a certain volume left by the air-jet which can be filled with flame, and this flame has a limiting temperature which cannot be exceeded. The wire, passing through this cone of flame receives heat, partly by radiation, but chiefly by conduction, and becomes melted; but there is a definite limit to the amount of heat which can be picked up by the wire passing through the flame, and a definite limit to the rate at which it can be melted. This cannot be increased by forcing more gas into the flame, as the extra gas is merely blown away by the air-jet. It is possible to increase the rate of melting by shaping the nozzles so as to leave room for a larger cone of flame, and experiments are in progress on this point. There is, therefore, a most definite economical quantity of gas which should be used in the pistol, this quantity being

about 1·5 cubic foot of hydrogen per minute, and 0·5 cubic foot of oxygen; or about 0·8 cubic foot of coal-gas to 0·65 cubic foot of oxygen for the present standard designs.

In refractory metals these quantities may be increased slightly, as a slightly higher temperature can be obtained if the burning gases are under a pressure greater than atmospheric, and this occurs if the gas quantities are increased, the inner surface of the air-jet acting to some extent as an enclosing wall to the flame. On the other hand, for the more easily fusible and oxidizable metals, such as tin, lead, and zinc, it is advisable to keep the gas quantities rather below the figure given, so as to avoid any possibility of overheating and burning any portion of the wire.

The outer jet performs a threefold purpose: it keeps the nozzles and wire cool, it cools the object, and it produces the requisite velocity.

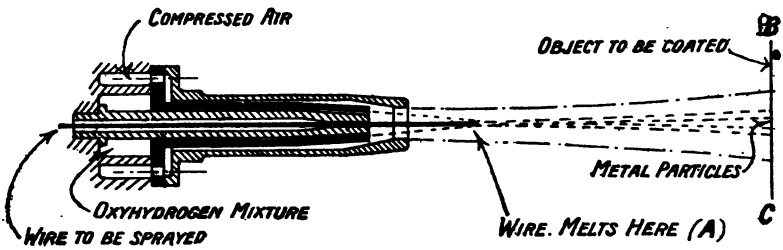


Fig. 145.—DIAGRAMMATIC REPRESENTATION OF MELTING AND SPRAYING JETS IN ACTION.

The velocity of the air leaving the jet will be independent of the volume discharged, and depends only upon the pressure at the jet, so long as there is no disturbance due to the entraining of air from the surrounding atmosphere. This, of course, will actually occur in practice, and the layer of air must have a certain thickness in order to prevent its being broken up, and its velocity destroyed by mixing with the surrounding atmosphere.

As at present constructed the standard pistol uses about 0·55 to 0·6 cubic foot per minute for every 1 lb. per square inch air pressure, so that with an air supply at 80 lb. per square inch, which is a very suitable figure for ordinary spraying, the air consumption will be from 45 to 50 cubic feet per minute.

The bulk of this will be from 830 to 920 grammes, and the mass of metal sprayed by this air will be from about 8 grammes in the case of iron to about 200 grammes in the case of lead.

The action of deposition is probably a complex one. The minute particles of solid metal are driven with such force against the object that, in some cases, they fuse, but, owing to their small relative size, are promptly chilled by the object to which they adhere. If any of the particles are molten or gaseous they will adhere. In addition, the suddenly chilled particles are possibly, or even probably, in the state of unstable equilibrium found in "Prince Rupert's Drops," and act like so many minute bombs, bursting on impact into almost molecular dimensions, and penetrating the smallest cracks and fissures of the object.

The process requires some care in manipulation, as, by varying the conditions, it is possible to spray porous or non-porous coatings, and, with some metals, anything from a pure metal to a pure oxide. With care, however, non-porous, oxide-free, adherent coatings can be produced, of almost any metal on almost any solid.

In addition to metals, it is possible to spray fusible non-metals, or, by stranded wires, alloys of metals or mixture of metals with non-metals.

The process is so new that its uses are still partly to be developed. But it is easy to see that it may have far-reaching value for protective coatings against weather or fire, for ornament, for electrical resistance and conductors, for the production of special alloys, for joint making, and for many other purposes.

Quite in a different category comes that of very fine casting. The surface of a pattern, polished or slightly greasy, is most minutely copied, and it is possible to produce process blocks very rapidly. It may be useful to line moulds before pouring in a metal. The application of the process to the production of very fine or coarse metallic powders is being investigated.

The bulk of the work has hitherto been carried on in laboratories, but the apparatus is gradually becoming used in the more progressive factories, where extended facilities, and the knowledge of specialised requirements, will ensure a rapid improvement in technique and results.

The research on the lower melting point metals has been greater than on the others, and undoubtedly the economy with them both can be greatly improved. Pre-

Fig. 146.—An Example of Sprayed Decorative Work.
(Aerograph.)

Fig. 147.—Shaded Work by the Aerograph.

heating of gases and air, supplementary flames acting in front of the main jet, and electrical methods of heating, are all still the subject of experiment.

The following metals are among those which have been successfully sprayed by this process :—Aluminium, brass, bronze, copper, cupro-nickel, iron, gold, nickel, silver, tin, zinc, lead.

It will be obvious that this method is a most useful one to employ when it is desired to prevent iron from rusting on machine parts which cannot possibly be treated by chemical or other anti-rust processes, and be rendered immune from rusting by treatment where they stand. To give some idea of the cost, it may be said that if the thickness of 0.001 of one inch of zinc is deposited, the cost of metal for coating 10 square feet would only be a fraction over 4d.; while for lead the cost would be about 2d. The amount of gas used is not a large item, being at the rate per minute of 0.50 cubic foot of oxygen and 0.55 cubic foot of coal gas when spraying zinc, and 0.101 cubic foot less in each case where lead is being used in the pistol. These figures are given on the authority of the "Daily Telegraph."

Fig. 148.—SHOW CARD

Fig. 149.—A Sprayed Frieze (Aerograph).

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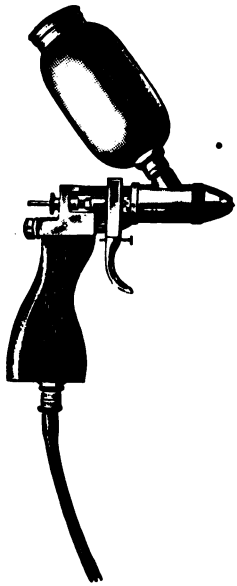

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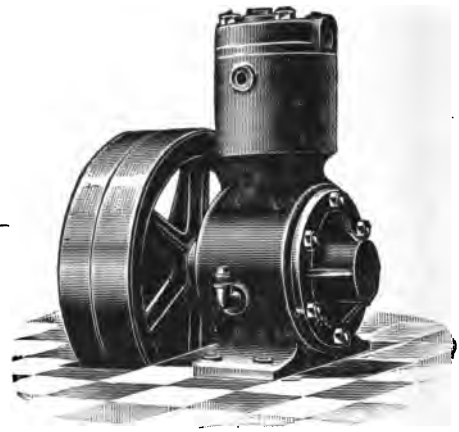

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